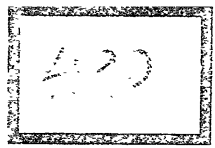

THE SILK INDUSTRY OF JAPAN

BY

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TOKYO

The Imperial Tokyo Sericultural Institute.

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PREFACE.

THIS work is intended to introduce to the world the sericultural industry of Japan, giving a full description of the history and the present state of this industry, and also venturing upon some impersonal opinions as to the possibility of its further development in the future. It is, therefore, a humble hope and assurance of the author that the reader may get some idea of the general features of the sericultural industry in this country.

In the compilation of this book, the author owes valuable assistance to Messrs. C. Tsuji, T. Hayashi, Y. Tsuchiya, Y. Machida, C. Yokota, Experts of this Institute, and to Mr. T. Mitani, an Assistant-Expert.

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THE SERICULTURAL INDUSTRY OF JAPAN.

CHAPTER I.

HISTORY OF THE SERICULTURAL INDUSTRY OF JAPAN.

The existence of silkworms as early as in *Jindai* (the Sacred Age) is stated on record, but whether their rearing was then practiced as an occupation is not ascertained. During the reign of the 14th Emperor, Chū-ai, 199 A.D., Koma-Ō, a descendant of a Chinese Emperor, came over to Japan and got naturalized, paying a tribute of precious things from China, among which were included some silkworm eggs. This was the first introduction of Chinese silkworm eggs into this country ever known in history. Some ninety years later, Tsudzuki-no-Kimi, son of Koma-Ō, also came over to Japan bringing with him the inhabitants of 127 districts of his country, who were, accordingly, distributed among various quarters of this Empire and ordered by the then Emperor Ō-jin to engage in silkworm rearing. This took place some 1020 years ago, and the real origin of the sericultural industry of Japan may be said to have dated from that time.

The succeeding Emperor Nin-toku showed his warm interest toward this industry by sending the Empress to visit Nurinomi, a Korean lady, who was engaged in silkworm rearing at Tsudzuki in the province of Yamashiro. This Imperial encouragement gave the people an affective inducement to pay further attention to this industry.

Another important event in the history of sericulture in Japan is to be met with in the reign of the 21st Emperor Yū-ryaku, who induced the Empress, by way of setting an example, to try rearing silkworms in person. The Emperor also gathered all the naturalized Chinese, who had been scattered throughout various districts, and made them undertake this industry more exclusively under the leading of Miki-no-Kimi, a descendant of Koma-Ō after six generations. An Imperial decree was also issued, encouraging the cultivation of mulberry trees in a greater extent in all places fit for such plantation. This reign is indeed marked by the unprecedented progress of sericulture in ancient Japan.

In the celebrated Constitution of Prince Shō-toku, promulgated in the reign of the 33rd Empress Suiko, about 1300 years ago, one clause is inserted to secure to the people freedom from public services during the seasons of farming and silkworm rearing. Fire warming was even practiced, as is recorded, in regulating the temperature of the rearing room in such remote days.

Some years afterwards, in the reign of the 36th Emperor Kō-toku, some 1260 years ago, a new system of collecting taxes was inaugurated, whereby taxes were made payable in silk textures, which caused a subsequent increase in the production

of silk fabrics. The 42nd Emperor, Bum-bu ordered by a special decree that every family should cultivate mulberry trees according to its class, viz., 300 trees for the first class, 200 and 100 for the second and the third respectively.

Up to this time sericulture had been restricted to the central and south-western parts of Japan, but during the reign of the 43rd Empress, Gem-myō, some of the rich families in the central part of Japan were transferred to the north-eastern part, and therefrom dates the origin of the sericulture in the north.

In the reign of the 60th Emperor, Daigo, some 1000 years ago, the districts producing silks of a superior quality were the following prefectures :—

Miye, Aichi, Shiga, Gifu, Hyōgo, Okayama, Hiroshima, Wakayama, Tokushima.

The districts producing silks of a medium quality were the following :—

Fukui, Ishikawa, Niigata, Kyōto, Tottori, Shimane, Yamaguchi, Kagawa, Ehime, Kōchi, Fukuoka, Nagasaki, Saga, Kumamoto, Ōita, Miyazaki, and the southern part of Shidzuoka.

The districts producing silks of an inferior quality were the following :—

The northern part of Shidzuoka, Yamanashi, Kanagawa, Tōkyō, Chiba, Ibaraki, Nagano, Gumma, Tochigi.

Thus it will be noted that the geological distribution of sericulture at that time was quite different from that of to-day, this industry flourishing more in the central and south-western parts than in the north-eastern districts.

The practice of silk-raising had been kept on in as lively a condition as before until twenty years later, by which time, however, farmers began to pay less attention to this industry, resulting in the gradual decrease of the production of silk; this was especially the case in the turbulent era of Gem-pei (the time of the contest of the two rival families of Minamoto and Taira).

It is an undeniable fact that the prosperity of industry of any kind depends upon, and goes together with, the political vicissitudes of a country. The peace Japan had been enjoying up to this time with little interruption had offered favorable conditions for the general development of sericulture, and the mode of paying taxes in silk fabrics, as has already been mentioned, had induced the people to give stronger efforts for the production of silk. But from the end of the 12th century to the end of the 16th century, the country was disturbed by civil discord; wars were frequent, farmers were overburdened with heavy taxes, and the youth were called off from farming for military service.

In this state of things, it was but natural that no due attention should have been devoted to such a delicate industry as sericulture. Another drawback was also brought on the practice of silk-raising by the prevalence of the use of cotton clothing, which had been gaining ground against the use of silk fabrics in the north-eastern and central parts of Japan some 400 years ago. The chief silk-producing districts at that time are given below:—

Chiba, Ibaraki, Gifu, Nagano, Gumma, Fukui, Ishikawa, Niigata, Kyōto, Tottori, Shimane, Hyōgo, Okayama, Ehime, Saga, Kumamoto, Miyazaki, Kagoshima.

This geological distribution of sericulture shows some difference as compared with that of 1000 years ago. The sericultural sphere seems to have moved somewhat in the north-eastern direction.

Towards the close of the 16th century peace began to prevail in the country by the establishment of the Tokugawa Dynasty, and industry of every description received fresh encouragement, sericulture naturally resuming its long-suppressed development. But as a result of frugality being the fundamental principle kept through in all state affairs by the successive *Shōgun*, the use of silk for clothing was permitted only to "*Samurai*" (military clan), and common people were strongly prohibited from wearing silken clothes, which gave considerable restriction to the demand for silk.

It may, however, be noticed that by the reign of the 118th Emperor, Kōkaku, about 100 years ago, the prevalence of the sericultural industry was moving still northwards. Here are given the chief silk-producing provinces at that time :—

Shiga, Gifu, Nagano, Gumma, Tochigi, Fukushima, Miyagi, Yamagata, Fukui, Ishikawa, Tōkyō, Yamanashi, Kyōto, Hyōgo.

After this time sericulture met with more or less encouragement; but at the time of that dreadful famine which occurred in 1785, devastating the whole country, the *Shōgun* issued a decree absolutely prohibiting the common people from wearing silk clothes, which influence was felt not only by silk traders, but extended to all silk-raisers.

Upon the opening of Yokohama harbor for foreign trade at the beginning of the Meiji era, the sericultural industry of Japan assumed a new aspect. Wide markets being now open,

the ever increasing demand for Japanese silk gave a fresh stimulus to the development of this industry, and the amount of exported silk has enormously increased year after year, till at present silk has assumed the foremost position of all exports from Japan, so much so that both the government and the people are giving every possible attention not only to the encouragement, but also to the further betterment of this industry.

Thus far we have treated of the general survey of the history of the sericultural industry in Japan before the Restoration. Here we are led to observe more at length the changes and growth of this industry since the beginning of the Meiji era.

It is to be well remembered that about fifty years ago, the silk-raisers of Italy and France, alarmed by the fearful ravages of pébrine, imported Japanese eggs with the view of introducing a healthy stock to replace the native races. The annual export of our egg-cards reached sometimes the enormous figure of over 1,000,000. In fact, the production of silkworm eggs was a profitable branch of industry at that time. But since M. Pasteur introduced his system of egg selection, the number of such exported egg-cards gradually decreased to 4,000 in 1886, to 800 in 1895, till at present the export is reduced literally to nothing.

Silk-reeling had so far been performed by means of the simple hand-wheels, but in 1869 Ono-gumi established a factory for 100 reelers at Tsukiji, Tōkyō, introducing filatures after the French model. This factory was removed three years later to Nihonmatsu, Fukushima prefecture, where it still remains by the name of the Sōshō-kwan. In 1870, the government also started a factory at Tomioka in Gumma prefecture, in which new

filatures were set and a Frenchman, Paul Bruner, was employed as an instructor, and the factory commenced its work in the following year. This gave rise to the successive establishment of many other factories in various localities, and at present we have throughout Japan 2,320 of those factories which employ more than 10 reelers each, the total number of the reeling basins provided therein amounting to 128,152.

Formerly, local silk-raisers used to sell off their products at Yokohama. In 1875, a certain Chōtaro Hoshino of Gumma prefecture tried the direct export of silk through Kindon & Co.; No. 89, Yokohama, which attempt, however, resulted in failure. In the following year, this man in company with a Momotarō Satō of Chiba prefecture, succeeded in executing the sale of 400 *kin** of his silk at the price of ¥650† per *kin* to a certain American merchant of New Jersey. This was the first instance of the direct export that has ever been known.

The establishment of the Dōshin-kwaisha at Yokohama in 1879 opened the way for the direct export, and the Yokohama Specie Bank inaugurated the following year afforded a great facility to its practical management.

It is a matter of course that the silk of forty years ago should have been much inferior to that of to-day. A greater part of the silk at that time was reeled from yellow cocoons, and consequently assumed a yellowish tint, which, however, not being much admired by the dealers concerned, gradually gave place to the white silk, so that at present the latter enjoys a unique importance in the field of this industry. The silkworms that had been reared in Japan were in the main the univoltine

* *kin* = 0.6 Kilogramme. ¥ = ½ Dollar.

race hatching in spring, but the rearing of the bivoltine race had also been tried for the summer crop. About fifty years ago, however, it was found by chance in Nagano prefecture that the silkworm eggs of the univoltine race preserved in a cave would retard their hatching until autumn. By this means the so-called *autumn silkworms* are now reared with satisfactory results, and the practice is quite extensive.

The stifling and drying of cocoons had usually been done by the heat of the sun, thus causing not a little harm to the quality of the silk so produced. The stifling apparatus by fire heating invented by the Tomioka factory, therefore, may be said to have been a great improvement in the method of cocoon preservation. In 1888, S. Morita succeeded in applying the canning method to the preservation of cocoons. In 1899, the Sericultural Institute at Nishigahara invented a certain cocoon drying apparatus fit for the practice in Japan, and brought its recommendation into public notice, which called forth many other successive improvements in the preservation of cocoons.

The government has frequently sent abroad specialists in order to make them investigate and observe the state of the sericultural industry in Europe and America, and foreigners have often been employed for the further betterment of the industry in Japan. In 1874, the Sericultural Experiment Place was opened by the Department of Home Affairs at Naitō-Shinjiku, Tōkyō, which, however, was abolished in 1879. As already mentioned, the fearful silkworm disease that had prevailed in France and Italy some years before, induced the government to establish the Station for the Investigation of

Silkworm Diseases in 1884, at Yamashita-chō, Kōjimachi-ku, Tōkyō. Careful examination practiced in this station proved the presence of pébrine in Japanese silkworms also. As an immediate measure, official regulations for the examination of silkworm eggs were promulgated in 1886, whereby silkworm eggs were made to undergo strict examination before practical use. Some months later, this station was moved over to Nishigahara, a suburb of Tōkyō, and there students from various silk-raising districts were trained in the methods of examining pébrine. This continued for three consecutive years, after which, the scope of this training was somewhat widened, and instruction was given there more at length in the general knowledge of sericulture.

Induced by the general development of society, another extension was introduced in the scope and system of this station, which was, thenceforward called the *Sericultural Institute*, according to the regulations issued in 1896. Three years later, another institute on the same basis was established in Kyōto, where experiments and instructions concerning silkworm rearing were exclusively conducted.

The need of reeling equipments being strongly felt by the Tōkyō Institute, the Filature Department was newly established in 1902 in addition to the Silkworm Department, and experiments and instructions regarding filature work were carried on there, so that these two Departments might combine their efforts for the perfection of the work aimed at.

Besides these two Institutes, many sericultural schools and institutes on a lower standard sprang up in a later date in various localities.

It is a most desirable as well as an essential thing in the silk trade both for the buyer and the seller to have an accurate knowledge of the quality and weight of the silk intended for such trade. In order to meet this necessity, which had long been felt and acknowlegded, the government established in 1895 two Silk Conditioning Houses, one at Yokohama and the other at Kōbe. The number of tests operated in the Kōbe Conditioning House, was, however, almost nil, while in the Conditioning House at Yokohama operations increased abundantly, so that the former was at length closed in 1897, and its business was carried over to the later. Since that time the number of operations in the Yokohama Conditioning House has been ever increasing, and at present the Silk Conditioning House has attained such importance that it is now considered to be an indispensable institution in the silk trade of Japan.

These governmental encouragements detailed thus far, combined with energetic endeavors on the part of sericulturists at large, have brought forth the prosperity and state of development that the sericultural industry of Japan is enjoying at present, as will be illustrated in the following chapter.

CHAPTER II.

THE PRESENT STATE OF SERICULTURAL INDUSTRY.

The sericultural industry of Japan has been given so much encouragement and protection from various quarters since the Restoration that it has attained remarkable progress and is now carried on almost everywhere throughout the Empire except in Saghalien.

Generally speaking, the production of silkworm eggs is undertaken on a comparatively large scale, and is more common in Nagano, Fukushima, Gumma, Aichi, Saitama, Yamanashi, Gifu, Yamagata, Shiga, and Tōkyō prefectures, while there are few, if any, who attempt silkworm rearing as an exclusive industry, this being carried on mostly as a supplementary employment of farmers. It may, therefore, be noted that silkworm rearers are found all over the country, though, of course, their number may vary according to the district.

In Japan, mulberry trees can be cultivated everywhere between the Hokkaidō and Formosa in an area extending over 23 degrees of latitude, which fact renders the rearing of silkworms possible at any place so far as economic circumstances allow. In fact, the number of those families, in which silkworm rearing is practiced, constitutes fully fifteen per cent. of all the families throughout Japan.

The reeling of silk from cocoons had long been performed by means of a "*sedentary reeling*" apparatus as a supple-

mentary employment of farmers, but since the introduction of filature or reeling machines some forty years ago, professional reelers have increased in number a great deal. Some are, however, still engaged in reeling with a somewhat improved *sedentary reeling* apparatus, while others use what may be called a "*foot reeling*" apparatus, a modification of the *sedentary reeling* apparatus and filature machine, the result being the co-existence of the professional reelers and farmer reelers, with a variety of scales in the standard of their work.

Filature machines are usually used in factories, where reeling is performed on a large scale. Among all the prefectures of Japan, Nagano stands foremost in filature work, Gumma, Yamanashi, Fukushima, Aichi, Saitama, Gifu, Yamagata, Tōkyō, Miye, Shidzuoka, Miyagi, Kanagawa, and Niigata following successively.

In order to give some idea as to the geological distribution of the sericultural industry in Japan, we insert here the tables showing the number of the families engaged in silkworm rearing, the amount of silkworm eggs, of cocoons, and of raw silk produced in each prefecture. The map attached is also intended to illustrate the development of the industry in each prefecture.

N. B. The number of the families rearing silkworms given here is the figure for 1907. The amounts of silkworm eggs, of cocoons and of raw silk are the average figures for the last five years.

Number of Families rearing Silkworms, 1907.

Prefectures.	Families engaged.
Tōkyō	29.103
Kyōto	25.210
Ōsaka	1.894
Kanagawa	37.384
Hyōgo	33.316
Nagasaki	8.331
Niigata	44.757
Saitama	98.078
Gumma	75.171
Chiba	36.433
Ibaragi	49.102
Tochigi	15.253
Nara	5.733
Miye	36.323
Aichi	71.888
Shidzuoka	53.286
Yamanashi	47.430
Shiga	24.989
Gifu	62.062
Nagano	108.004
Miyagi	25.733
Fukushima	63.183
Iwate	21.189
Aomori	3.454
Yamagata	41.333
Akita	14.365
Fukui	27.449

Prefectures.	Families engaged.
Ishikawa	20.153
Toyama	14.037
Tottori	18.665
Shimane	25.133
Okayama...	13.057
Hiroshima	6.962
Yamaguchi	18.483
Wakayama	9.670
Tokushima	24.950
Kagawa	3.485
Ehime	20.708
Kōchi	35.546
Fukuoka	12.676
Ōita	24.325
Saga...	25.506
Kumamoto	33.901
Miyazaki	17.141
Kagoshima	27.597
Okinawa	484
Hokkaidō...	7.797
Total	1.421.030

N. B. Silkworms are reared in three seasons in Japan, i. e. spring, summer and autumn. But generally the families rearing "*spring silkworms*" are the same as those of the "*summer*" and "*autumn rearing.*" Thus the above mentioned statistics are the number of the spring raisers only.

Production of Silkworm-eggs.

Prefectures.	Cellular Reproduction. No. of Moths.	Industrial Reproduction. Sheet.
Tōkyō	894.047	79.389
Kyōto	4.470.950	50.302
Ōsaka	27.759	1.518
Kanagawa	763.673	15.098
Hyōgo	1.237.528	26.937
Nagasaki	444.341	11.085
Niigata	912.521	59.132
Saitama	2.322.906	29.548
Gumma	2.923.613	205.789
Chiba	473.377	24.218
Ibaragi	788.811	51.815
Tochigi	416.068	72.227
Nara	5.060.608	6.459
Miye	1.695.774	64.918
Aichi	1.390.710	112.933
Shidzuoka	3.634.267	66.220
Yamanashi	2.331.992	183.787
Shiga	1.936.428	306.838
Gifu	5.551.302	186.356
Nagano	14.916.648	2.411.281
Miyagi	2.101.922	58.822
Fukushima	4.704.051	363.011
Iwate	224.373	14.033
Aomori	265.128	4.158
Yamagata	4.604.100	121.429
Akita	421.840	135 774

Prefectures.	Cellular Reproduction. No. of Moths.	Industrial Reproduction. Sheet.
Fukui	320.516	66.967
Ishikawa	178.412	11.020
Toyama	645.761	56.426
Tottori	1.318.787	33.082
Shimane	2.457.144	18.482
Okayama	176.200	10.777
Hiroshima	373.409	6.170
Yamaguchi	218.813	5.960
Wakayama	695.689	1.695
Tokushima	1.398.084	10.044
Kagawa	23.322	1.047
Ehime	1.274.118	21.344
Kōchi	1.005.722	22.281
Fukuoka	287.792	3.556
Ōita	693.563	15.223
Saga	169.117	5.310
Kumamoto	3.848.845	26.900
Miyazaki	270.336	19.786
Kagoshima	401.251	16.227
Okinawa	—	—
Hokkaidō	1.098.026	35.723
Total	88.740.558	5.349.216

N. B. The egg-grains on a card of the "*industrial reproduction,*" are the result of the deposits of 100 female moths.

Production of Cocoons.

Prefectures.	Quantity. Kg.
Tōkyō	2.961.523
Kyōto	2.005.715
Ōsaka	86.377
Kanagawa	2.821.985
Hyōgo	2.011.526
Nagasaki	119.743
Niigata	2.412.819
Saitama	8.198.651
Gumma	8.337.739
Chiba	2.852.164
Ibaragi	4.107.404
Tochigi	1.483.179
Nara	358.179
Miye	2 253.599
Aichi	5.213.547
Shidzuoka	3.295.146
Yamanashi	4.267.899
Shiga	2.565.666
Gifu	5.501.020
Nagano	17.281.278
Miyagi	2.614.065
Fukushima	7.604.622
Iwate	1.465.109
Aomori	142.312
Yamagata	3.904.096
Akita	634.968
Fukui	1.233.384

Prefectures.	Quantity. Kg.
Ishikawa	1.050.135
Toyama	539.631
Tottori	1.147.194
Shimane	1.075.176
Okayama	637.592
Hiroshima	281.512
Yamaguchi	430.873
Wakayama	430.123
Tokushima	697.089
Kagawa	97.774
Ehime	954.533
Kōchi	1.114.840
Fukuoka	284.024
Ōita	739.903
Saga	318.553
Kumamoto	1.374.946
Miyazaki	645.090
Kagoshima	654.013
Okinawa	6.711
Hokkaidō	270.753
Total	109.199.260

Production of Raw Silk.

Prefectures.	Quantity. Kg.
Tōkyō	213.425
Kyōto	143.380
Ōsaka	2.944
Kanagawa	159.842

Prefecturers.	Quantity. Kg.
Hyōgo	125.848
Nagasaki	6.930
Niigata	158.848
Saitama	397.720
Gumma	590.801
Chiba	74.212
Ibaragi	126.388
Tochigi	47.872
Nara	11.707
Miye	195.238
Aichi	413.616
Shidzuoka	187.209
Yamanashi	449.687
Shiga	143.833
Gifu	353.242
Nagano	1.839.540
Miyagi	182.334
Fukushima	425.308
Iwate	77.440
Aomori	3.626
Yamagata	283.489
Akita	47.981
Fukui	104.586
Ishikawa	37.635
Toyama	69.562
Tottori	74.092
Shimane	79.319
Okayama	47.984

Prefecturers.	Quantity. Kg.
Hiroshima	26.936
Yamaguchi	23.977
Wakayama	25.320
Tokushima	22.534
Kagawa	2.100
Ehime	101.976
Kōchi	83.894
Fukuoka	19.080
Ōita	39.712
Saga	19.729
Kumamoto	95.339
Miyazaki	55.657
Kagoshima	31.297
Okinawa	161
Hokkaidō...	6.892
Total	7.631.095

Besides, in order to show the state of sericultural industry in Japan, let us give the principal statistics as follows:—

Area of Mulberry farms, 1903 to 1907.

Year.	Farm. Acre.
1903	782.302
1904	796.432
1905	833.271
1906	893.923
1907	957.943
Average..	852.774

Annual production of Silkworm-eggs and the Number of Families engaged in the Egg-card manufacture, 1903 to 1907.

Year.	Families engaged.	Cellular Reproduction. No. of Moths.	Industrial Reproduction. Sheet.
1903	17.404	44.791.423	5.163.072
1904	18.031	57.612.006	5.530.658
1905	14.189	56.672.349	5.039.934
1906	13.514	96.781.913	5.077.176
1907	15.101	187.945.101	5.935.242
Average ...	15.648	88.760.558	5.349.216

Number of Families engaged in Silkworm Rearing, 1903 to 1907.

Year.	Spring.	Summer.	Autumn.
1903	1.445.220	587.782	652.997
1904	1.474.587	587.215	712.618
1905	1.484.750	549.649	746.038
1906	1.407.766	564.619	804.554
1907	1.421.030	593.190	890.136
Average ...	1.446.671	576.491	761.269

Annual production of Cocoons, 1903 to 1907.

Year.	Spring Cocoons Kg.	Summer Cocoons Kg.	Autumn Cocoons Kg.	Total amount. Kg.
1903 ...	61.947.913	14.204.849	20.836.942	96.989.704
1904 ...	69.390.354	14.657.015	21.887.224	105.934.593
1905 ...	66.423.057	13.784.061	21.890.636	102.097.754
1906 ...	69.918.887	15.505.452	25.948.216	111.372.555
1907 ...	84.035.635	17.596.306	27.969.752	129.601.693
Average ..	70.343.169	15.149.536	23.706.554	109.199.599

Number of Raw Silk manufacturers, 1903 to 1907.

I. Total Manufacturers.

Year.	Manufacturers having under 10 basins.	Manufacturers having 10 to 49 basins.	Manufacturers having 50 to 99 basins.	Manufacturers having above 100 basins.	Total.
1903	—	—	—	—	402.475
1904	—	—	—	—	408.055
1905 ...	407.224	3.809	603	307	411.943
1906 ...	397.885	2.916	597	330	401.728
1607 ...	392.581	3.770	619	369	397.339
Average..	399.230	3.498	606	335	404.308

II. Filature Manufacturers.

Year.	Manufacturers having under 10 basins.	Manufacturers having 10 to 49 basins.	Manufacturers having 50 to 99 basins.	Manufacturers having above 100 basins.	Total.
1903	—	—	—	—	—
1904	—	—	—	—	—
1905 ...	5.173	1.677	560	297	7.707
1906 ...	4.392	1.611	564	326	6.893
I907 ...	4.839	1.615	566	364	7.384
Average..	4.802	1.634	563	329	7.328

III. Manufacturers using Sedentary Reeling Instruments.

Year.	Manufacturers having under 10 basins.	Manufacturers having 10 to 49 basins.	Manufacturers having 50 to 99 basins.	Manufacturers having above 100 basins.	Total.
1903	—	—	—	—	—
1904	—	—	—	—	—
1905 ...	354.792	1.777	22	9	356.600
1906 ...	350.227	1.116	6	2	351.351
1907 ...	351.133	1.954	24	4	353.115
Average..	352.051	1.616	17	5	353.689

IV. Doppioni Manufacturers.

Year.	Manufacturers having under 10 basins.	Manufacturers having 10 to 49 basins.	Manufacturers having 50 to 99 basins.	Manufacturers having above 100 basins.	Total.
1903	—	—	—	—	—
1904	—	—	—	—	—
1905 ...	47.259	355	12	1	47.636
1906 ...	43.266	189	27	2	43.484
1907 ...	36.609	201	30	1	36.841
Average..	42.378	248	26	1	42.653

Annual production of Raw Silk, 1903 to 1907.

Year.	Amount of production by Filature. Kg.	Amount of production by Sedentary reeling. Kg.	Total. Kg.
1903	4.361.591	2.554.871	6.916.462
1904	4.486.268	2.491.433	6.977.701
1905	4.526.655	2.369.958	6.896.614
1906	5.282.258	2.456.254	7.738.512
1907	6.169.778	2.598.300	8.768.078
Average ...	4.965.311	2.494.162	7.459.473

Annual production of Doppioni, 1903 to 1907.

Year.	Quantity. Kg
1903	575 573
1904	509.994
1905	412.588
1906	475.228
1907	463.337
Average	487.342

Annual production of Waste Silk, 1903 to 1907.

Year.	Quantity. Kg.
1903	1.475.918
1904	1.640.398
1905	1.716.822
1906	1.948.014
1907	1.996.873
Average	1.755.605

N. B. The waste silk includes "*Noshi*" and "*Kibiso.*"

CHAPTER III.

GOVERNMENT ENTERPRISES FOR SERICULTURAL INDUSTRY.

The present development of the sericultural industry of Japan owes a great deal to the encouragement from the Imperial Households. Not to mention those given by our ancient emperors, Ō-jin, Nin-toku, Yū-ryaku, the late Empress Dowager was, as is well known, personally engaged in rearing silkworms, reeling and even weaving in the Aoyama Detached Palace. It may also be noted here that H. I. M. the Empress and H. I. H. the Crown Princess were pleased to visit the Tōkyō Sericultural Institute last year in order to see how the work of sericulture was being done there. In fact, the Crown Princess is giving a great encouragement to the industry by her personal experiments in silkworm rearing in the Royal Palace, every season. In response to the Imperial wishes the government is also giving every encouragement and assistance to this industry, which may be summarized as follows :—

I. Instruction and Investigations.

The enterprises as regards instruction and investigations vary a great deal. Here we shall give some of the chief details.

A. Sericultural Institutes.

Sericultural Institutes originated, as mentioned in the preceding chapter, in the Station for the investigation of

Silkworm Diseases established in 1884. At present there are two of them, one in Tōkyō, the other in Kyōto, both under the direct control of the Minister of Agriculture and Commerce, intended to give instruction and to conduct experiments concerning sericultural industry. The Tōkyō Sericultural Institute is situated at Nishigahara, Tōkyō, and the scope of the work is divided into the five departments, viz., (1) The Silkworm Department, (2) The Filature Department, (3) The Summer and Autumn Silkworm Department, (4) The Department of Reports, (5) The Department of General Affairs. The Silkworm and the Filature Department conduct experiments as well as give instruction, while the Summer and Autumn Silkworm Department conducts experiments exclusively, and has its branch office at Matsumoto, Nagano prefecture. The Silkworm Department provides instruction to the male students, the course of study extending over three years. The students to be admitted therein must all be the graduates of Middle Schools and their number must not exceed sixty. The Filature Department gives instruction to both male and female students, the course of study and the number of the students in the Male Department being just the same as in the Silkworm Department, whilst in the case of the female students, the instruction is divided into two courses, Regular and Special, the former admits twenty students, all of whom must be the graduates of the Higher Course of the Primary School, engaged in filature work, and the term of study extends over two years; the latter admits forty students, all of whom must be the graduates of the Lower Course of the Primary School, engaged in filature work, and the term of study extends over ten months.

THE IMPERIAL TŌKYŌ SERICULTURAL INSTITUTE.

MR. IWAJIRO HONDA,
THE DIRECTOR.

THE IMPERIAL KYOTO SERICULTURAL INSTITUTE.

MR. SHIGETANE ISHIWATA,
THE DIRECTOR.

The total number of the graduates from this Institute up to 1908, is as follows :—

Silkworm Department		2,002
Filature Department	male	98
	female	172
Total		2,272

As to the present state of these graduates, some are teaching either in governmental or in private schools, some are working in prefectural government offices with credit and skill, while some are personally engaged in the actual management of this industry ; and most of the female graduates are employed in filatures and factories as women teachers, all affording every possible effort and playing an important part in the development of the sericultural industry throughout Japan.

Besides instruction, the Silkworm, Filature and Summer and Autumn Silkworm Departments conduct various experiments and investigations, and the results collected and printed are distributed to those interested in this industry. The Institute also sends out its officers to different localities from time to time and gives lectures in order to disseminate the general knowledge of sericulture.

Egg-cards of elaborate preparation are also distributed to silkworm rearers with the aim of propagating superior varieties of silkworms. All queries concerning sericulture propounded by the general public are readily answered by the expert officers of the Institute.

The Kyōto Sericultural Institute is situated at Kinugasa, Kyōto, and its scope of work consists of the four departments,

viz., (1) The Silkworm Department, (2) the Female Department, (3) the Department of Reports, (4) the Department of General Affairs. The Silkworm Department provides instruction as well as conducts experiments, while the Female Department gives instruction only. The instruction of the Silkworm Department which is limited to male students, is divided into two courses: Regular and Special; the former is just the same as that of the Tōkyō Sericultural Institute in its term of study and the number of students to be admitted, while in the latter the stated number of students is sixty, the term of study extending over seven months, and the applicants for admission must be the graduates of the Higher Course of the Primary School, who have been engaged in sericulture. The Female Department provides instruction in sericulture and the stated number of students to be admitted is sixty, the qualification for admission being the graduation from the Higher Course of the Primary School, the term of study extends over two years.

The number of graduates from the Silkworm Department up to 1908 was 688, while the Female Department has no graduates so far, having been established only last year.

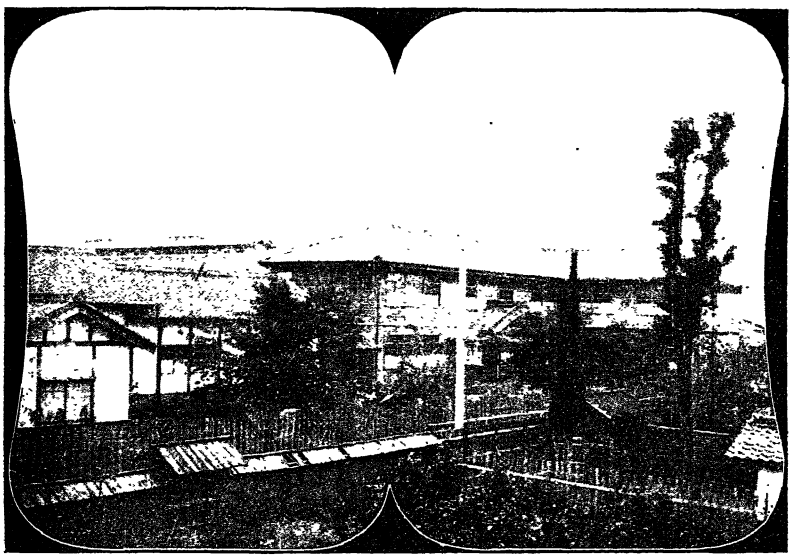
The present state of these graduates may be said almost the same as that of the Tōkyō Sericultural Institute.

B. The Higher Sericultural School.

This school is to be established at Uyeda, Nagano prefecture, under the direct control of the Minister of Education with the same curriculum and course of study as that of the Tōkyō Sericultural Institute. Its actual opening will take place within a year or two.

C. The Prefectural Schools of Sericulture.

The Sericultural Schools under the direction of prefectural governors are the following four:—

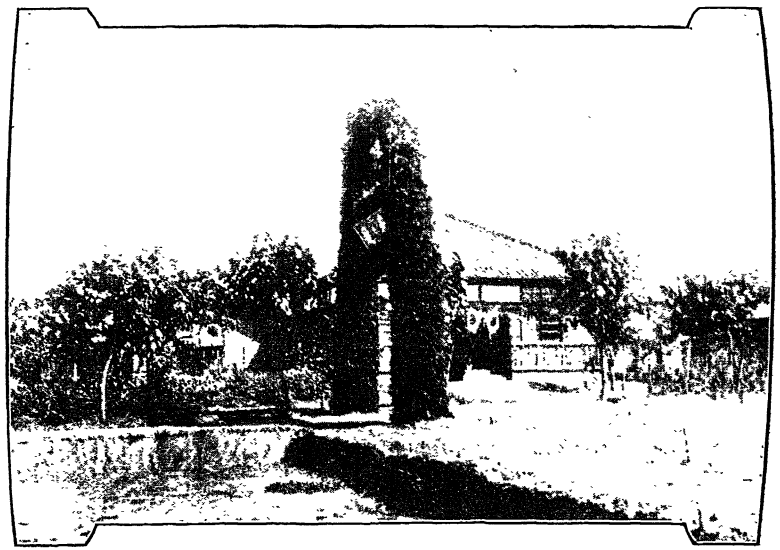


NAGANO-KEN CHIISAGATA SERICULTURAL SCHOOL.

(*a.*) The Nagano-ken Chiisagata Sericultural School.
(*b.*) The Fukushima-ken Sericultural School.
(*c.*) The Toyama-ken Sericultural School.
(*d.*) The Hyōgo-ken Sericultural School.

The former three have the same standards of instruction as the Middle School and the last the same as the Higher Course of the Pimary School.

Besides these, there are thirteen sericultural schools established by *gun* (county). As for private institutions, there



FUKUSHIMA-KEN SERICULTURAL SCHOOL.

are many of them; two of them named below are somewhat noteworthy. They are the Takayama-sha Sericultural School, at Fujioka-machi, Tano-gōri, Gumma prefecture, and the Kyōshin-sha Sericultural School, at Kodama-machi, Kodama-gōri, Saitama prefecture.

D. The Prefectural Institutes of Sericulture.

Sericultural Institutes under the control of prefectural governors are all intended to give training to the students, to conduct various experiments, and to send their officers throughout different districts in order to give guidance to those engaged in silk-raising. The standards of instruction given therein vary according to the districts, where such institutes are situated. The sites of those Institutes are shown below:—

(*a.*) The Hokkaidō Sericultural Institue, Sapporo, Hokkaidō.

(*b.*) The Niigata-ken Sericultural Institute, Nagaoka-shi, Niigata prefecture.

(*c.*) The Miye-ken Sericultural Institute, Komata-mura, Watarai-gōri, Miye prefecture.

(*d.*) The Aichi-ken Sericultural Institute, Hotei-machi, Nishi-kasugai-gōri, Aichi prefecture.

(*e.*) The Aomori-ken Sericultural Institute, Shinjō-mura, Higashitsugaru-gōri, Aomori prefecture.

(*f.*) The Shimane-ken Sericultural Institute, Hirata-machi, Hinokawa-gōri, Shimane prefecture.

(*g.*) The Okayama-ken Sericultural Institute, Ninomiya-mura, Komota-gōri, Okayama prefecture.

(*h.*) The Saga-ken Sericultural Institute, Koshiro-machi, Koshiro-gōri, Saga prefecture.

Besides these, there are five sericultural institutes established by counties. Private institutes are innumerable, the one at Ayabe-machi, Ikaruka-gōri, Kyōto prefecture, called the Jōtan Sericultural Institute, enjoys some reputation. As to such temporary institutes and training places as are open only during the rearing season, they are indeed countless.

E. Schools and Institutes providing the Sericultural Course in the Curriculum.

In the Agricultural College of the Tōkyō Imperial University instruction is given in sericulture besides other subjects, and various sericultural experiments are performed both theoretically and practically. The same is the case with the Morioka Higher Agriculture and Forestry School and most of the agricultural

schools in various prefectures and counties, in which sericulture is placed among the subjects of studies provided. Moreover, in nearly all agricultural training places, sericultural instruction and investigations assume the chief feature of their works. So, it might safely be added that the instruction and investigations concerning sericultural industry are now being undertaken in every part of Japan with energy and assiduity.

F. Experiments and Investigations.

Sericultural experiments and researches are sometimes conducted likewise in local Agricultural Experiment Stations, as in the various institutions above described, and the results of such experiments and researches are usually published in book form and distributed free of cost to the silk-raisers at large with a view to improve this industry.

II. ENCOURAGEMENTS.

These previously mentioned equipments for instruction, experiments, and investigations have no other aim than the improvement and propagation of the silk industry, but further attempts are very frequently made by the central government and the lower local offices to give direct and substantial encouragement in stimulating the rapid progress of the industry, which fact may be illustrated in the following articles.

A. Exchequer Subsidies for Industrial Schools.

At the establishment of any industrial school in the country, the government sometimes gives aid towards its fund, or affords a subsidy for its annual expenses.

B. Exchequer Subsidies for Agricultural Training Places and Experiment Stations.

This kind of subsidy is granted alike as in the preceding case.

C. Special Subsidies for Agricultural Experiment Stations and Agricultural Training Places.

Tha government may sometimes order any local Agricultural Experiment Station to undertake a certain specified experiment, for which a special subsidy is often granted. To quote some examples: annual subsidies have been given to the four Agricultural Experiment Stations in Miyagi, Gumma, Miyazaki, and Shimane prefectures, and the Sericultural Institute in Miye prefecture, for their respective specified experiments concerning mulberry cultivation. The eleven Agricultural Experiment Stations in Fukushima, Yamagata, Nagano, Gumma, Aichi, Shiga, Okayama, Fukuoka, Kagoshima, Ishikawa, and Tottori prefectures, also received subsidies respectively for experiments regarding the varieties of silkworms.

D. Encouragement for the Increase of Mulberry Plantations.

The government has been giving a certain amount of subsidy to induce the enlargement of mulberry plantations.

E. Subsidies from the Local Government Offices.

Local Government Offices likewise afford subsidies for the establishment or support of industrial schools and agricultural training places.

F. Circuit Lecturers.

The effectual improvement of silkworm rearing and filature can only be attained through the combined efforts all those who follow the proper methods of silk-raising based upon scientific investigations. So in all prefectures, counties, towns, and sericultural associations, those who are well qualified in the knowledge and practice of sericulture are employed as circuit lecturers in order to give direct guidance and encouragement to those engaged in this industry. Some circuit lecturers are employed all the time, while others are only for the silkworm season. In either case, such lecturers are supplied from among the graduates of the before-mentioned schools or institutes, so that the effect of this system is very encouraging.

G. Competitive Exhibitions.

These exhibitions aim at giving encouragement to sericulturists by collecting and exhibiting their products and giving a chance to study the manners and devices taken by others and the results actually achieved, thus giving a stimulus for the betterment of this industry. These are usually undertaken by the central government, or the local offices, but sometimes private associations may open such exhibitions under the auspices of the government, or local offices. Prizes or certificates of excellence are given to those whose exhibits have shown superiority either in quality or manufacture. The number of such exhibitions has also increased to the annual figure of fifty.

III. Precautions against Silkworm Diseases.

While the government is thus on one hand striving for the dissemination and progress of sericulture by every possible means, it is also on the other hand, taking great pains for the precaution against silkworm diseases by the compulsory force of law so that the modes for preventing such diseases may be observed in every particular. This was so done, because the acute contagion of these diseases can not, as is usually the case, be properly checked by mere individual endeavors. The first promulgation of such regulations came in the form of "the Law for the Examination of Silkworm-Eggs" issued in 1886 with the intention of preventing the most fearful silkworm disease, pébrine. The enforcement of this law was postponed for some time, and the matter was left to the discretion of each prefectual administrator. This indulgence, however, instead of bringing the desired effect, rather tended to loosen the observation of this law. Consequently, another law No. 22 was issued prescribing the Regulations for the prevention of Silkworm Diseases, thus giving uniformity to the methods and the practice to such precautions.

Here are cited some chief articles of these regulations:—

Art. 1. Silkworm diseases prescribed in this law are five in number as follows:—

Pébrine, Flacherie, Muscardine, Grasserie and '*Uji*'-*disease*.

Art. 2. All silkworm-egg producers, silkworm rearers, raw silk producers, cocoon dealers, and those engaged in stifling and drying cocoons shall come under the control of this law.

ART. 3. Those parties stated in the preceding article shall strictly follow the prescribed methods necessary for the prevention of the various silkworm diseases.

MICROSCOPICAL EXAMINATION OF THE FEMALE MOTH.

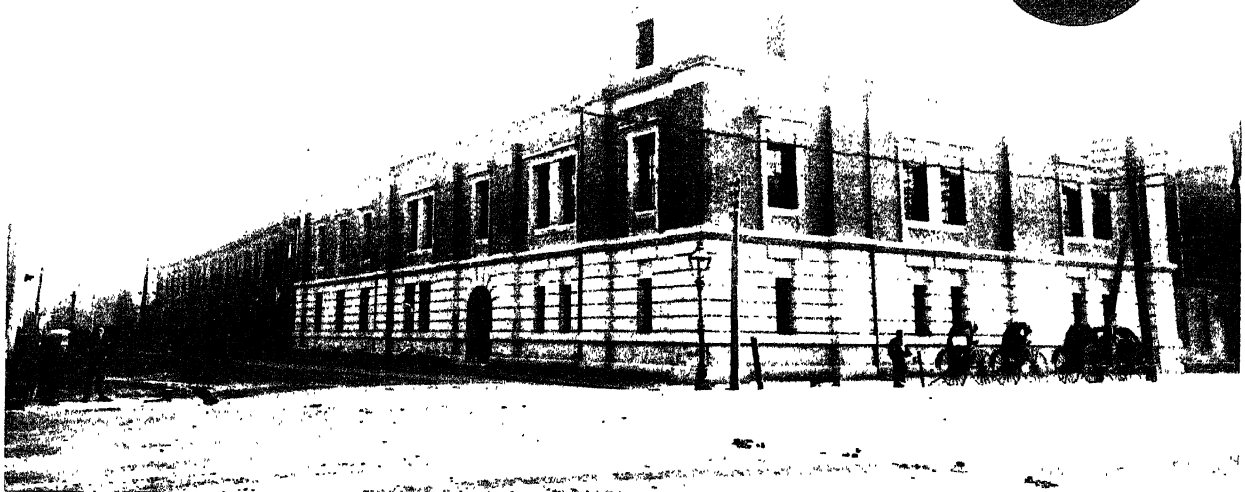
ART. 4. Silkworm-egg producers shall observe the following provisions :—

(*a.*) Silkworm egg-cards for reproductive purposes shall be prepared according to the cellular system.

(*b*) Silkworms of imperfect growth, or cocoons of inferior quality shall not be used for reproductive purposes.

(*c.*) Silkworm rearing rooms and implements shall be disinfected every year or at every rearing season.

(*d.*) All such silkworm egg-cards hatched off, silkworms in the course of rearing, cocoons, pierced cocoons, moths, and eggs, that are intended for reproductive



IMPERIAL JAPANESE SILK CONDITIONING HOUSE.

MR. AKIRA SHITO,
THE DIRECTOR.

purposes shall undergo strict examination by the office in charge.

The offices for the prevention of the silkworm diseases are 132 in all throughout Japan, the number of the offices employed therein amounting to 3,175, the annual expenses paid out for this purpose by the central government or prefectural offices reaches the vast sum of nearly ¥1,000,000.

IV. Conditioning of Raw Silk.

A greater part of the raw silk produced in Japan is exported into Europe and America, mostly into the latter, and its consumption at home is comparatively very small, the export of silk fabrics being likewise limited to a small figure.

As the filament of raw silk is very fine, it requires special tact and delicacy to get at the true quality of raw silk, and its strong humidity renders its weight subject to constant change, which is a source of serious difficulties in the dealing with raw silk. The government, therefore, judged it an indispensable measure for removing these difficulties to have some institution established for the conditioning of raw silk, and in consequence, in 1895 the law No. 32 was issued prescribing the regulations relating to the Silk Conditioning House. The construction of this institution was commenced at Yokohama, the central market of silk trade, and the inauguration took place in August of the following year (1896). The management of this house was modeled after the regulations of the Conditioning Houses in Europe and America, more particularly after those at Lyon, and the work is classified into the following four operations:—

1. Test for net weight.
2. Test for conditioned weight.
3. Test for boil-off.
4. Test for quality (winding, size, cleanliness, tenacity and elasticity).

A certificate is made out of each test in two languages, Japanese and French, the latter being intended for foreigners.

At the beginning of this establishment, the intended purpose of this house was not fully understood by the people, so the requests for conditioning were not very numerous, but the usefulness and value of this institution was gradually recognized, and the number of tests began to show rapid increase year after year, so much so that in 1901 and 1907 an extensive enlargement was made in its building, apparatus, and officials, giving a fresh impetus to its work, and at present 1,000 tests for net weight 600 tests for conditioned weight, and 500 tests for quality are daily executed in this house with ease.

The following table shows the annual number of tests performed in the Silk Conditioning House at Yokohama for the last five years.

Year.	Tests for net weight.	Tests for conditioned weight.	Tests for quality.	Tests for boil-off.	Total.
1904	33	41,998	28,544	6	70,581
1905	13	32,527	27,909	76	60,525
1906	0	45,196	35,503	59	80,758
1907	5	37,807	46,824	4	74,640
1908	10	43,036	54,666	11	97,723

BARON MASANAO MATSUDAIRA, THE DIRECTOR.

THE SERICULTURAL ASSOCIATION OF JAPAN.

H. I. H. PRINCE FUSHIMI, THE HONORARY PRESIDENT.

CHAPTER IV.

SERICULTURAL ASSOCIATIONS.

The existing number of those private associations intended for the progress and improvement of sericulture may be numbered by the hundred, among which the Sericultural Association of Japan stands foremost. Here we shall describe some of the chief examples of such associations.

I. THE SERICULTURAL ASSOCIATION OF JAPAN.

This association was established in February, 1892, for the furtherance of sericulture by making investigations and researches in the theory, art, and practical management of the industry, and at the same time, for the mutual exchange of knowledge among the members; and after going through many changes and transformations, it has attained to the present state of prosperity. The office is at Sanchōme, Nishiki-chō, Kanda, Tōkyō. It has at its head the Honorary President and Patron H. I. H. Prince Fushimi, and Baron Masanao Matsudaira takes the present presidency, with 30 councillors appointed from among the influential men in the sericultural circle. Its Board of investigation includes many noted scholars and sericulturists throughout the country, and the members reach the enormous number of 60,000, thus forming an association of unique importance in the sericultural field of Japan. The scope of work managed in this association is summarized as follows :—

1. Making investigations and researches regarding sericulture.
2. Making, in case of necessity, petitions to the government on behalf of the sericulturists.
3. Giving answers to queries concerning sericulture propounded by the government offices in charge.
4. Giving answers to queries concerning sericulture from the general public.
5. Giving efforts for the expansion of the market for our silk.
6. Forming connections with sericultural associations abroad.
7. Investigation of the services rendered by sericulturists and their recognition.
8. Opening competitive exhibitions of sericultural products, implements and apparatus.
9. Giving lectures and instruction in sericulture.
10. The compiling and translation of books on sericulture to be distributed among the members.
11. The publication of monthly reports to be distributed among the members.
12. The publication of a series of lectures on sericulture for the benefit of those interested in the industry.
13. Giving efforts for the development of the co-operative work concerning sericulture.
14. Introduction and supply of teachers and experts in sericulture.
15. Giving encouragement to the growth of this industry by every possible means.

This association has its branches in every prefecture throughout the country, and a firm connection is constantly kept alive between the main office and the branches, so that

the object of the association may be executed effectively. Women's departments are also attached to this association in various districts so that the female members may be induced to cultivate the admirable virtues of frugality and economy as well as to improve their mutual intercourse.

II. The Takayama-sha and the Kyōshin-sha.

There are a great number of those corporations intended for the improvement and growth of the sericultural industry, but the above mentioned two are the most important.

The Takayama-sha.

This association is at Fujioka-machi, Tano-gōri, Gumma prefecture, established in 1873, and its function is to give supervision and encouragement to the members, as well as to train instructors who are to be sent out to various districts to improve the management of the industry, thus contributing a great deal whether directly, or indirectly, to the development of sericulture. The present number of the members is some 40,000, and those who are trained therein amount to some 2,400.

The Kyōshin-sha.

This association is at Kodama-machi, Kodama-gōri, Saitama prefecture. Since its establishment in 1877, it has passed through many variations. Its function is exactly the same as that of the Takayama-sha, highly conducive to the furtherance of the industry. It has some 36,000 members, and those trained therein are some 3,200.

III. Sericultural Guilds.

The government issued in 1898 a law relating to the Chief Exports Guilds with a view to induce the improvment of the chief exports from Japan. The law of this kind was later found necessary not only for exports, but also for all the chief products of Japan, and accordingly, in 1890, the scope of this law was extended so as to cover the general products by the promulgation of the revised law relating to the Chief Products Guilds. These guilds under this law are juridical persons or associations organized by those engaged in the same occupation in a certain locality with the purpose of removing defects and increasing profits in the practical management of their occupation by the joint efforts of the members. The enforcement of this law proved effectively likewise in making the silk raisers combine themselves into such guilds, with the result that their products have been much improved to the immense benefit of the members. As the promulgation of this law was a matter of quite recent occurrence, the establishment of these guilds is not yet so universal as is desired.

The present number of such institutions is as follows :—

Sericultural Guilds...	67
Silkworm-egg Guilds	35
Raw Silk Guilds	21
Silkworm Rearers' Guilds	1
Silkworm Rearers' and Silkworm-egg Producers' Guilds	2
Double Cocoon Reelers' Guilds	1
Total	129

In order to keep connection among these guilds, two or more of them unite themselves in a guild-union, which is also a juridical person or association prescribed by the law. The number of these unions is as follows :—

Sericultural Guild-union	5
Silkworm-egg Producers' Guild-union... ...	1
Raw Silk Producers' Guild-union	1
Total	7

IV. Sericultural Co-operative Societies.

In March, 1898, the government issued the law relating to the Co-operative Society, the object of which is to induce the industrial as well as economical expansion of the people, and the societies organized in conformity to this law are sanctioned as juridical persons or associations. The present number of the societies concerning sericulture established under this law is shown below :—

Socieities for Production, Sales, and Consumption	206
Credit Societies...	1,139
Societies with the combined function of the above two sorts of societies	1,091
Total	2,442

Thus it may be seeen that the sericultural co-operative societies occupy 57 % of the whole number (4,264) of the Industrial Co-operative Societies.

V. Miscellaneous Societies.

Besides those above mentioned societies, there are thousands of those societies, whether temporary or standing, that have to do with sericultural, scientific, or miscellaneous technological investigations.

CHAPTER V.

THE CULTIVATION OF MULBERRIES.

The total area of the mulberry farms in Japan is 957552,61 acres, according to the investigations in 1907. It is 7,44 per cent., comparing to the total cultivated lands, 12876465,735 acres and over 16,2 per cent. to the total farms and they tend to increase gradually year after year.

The percentage of the mulberry farms to the cultivated lands in each prefecture is as follows:—

Prefectures.	Percentages.	Prefectures.	Percentages.	Prefectures.	Percentage.
Gumma ...	31,5	Iwate	7,7	Akita	4,2
Yamanashi ...	30,2	Ibaragi	7,5	Shimane ...	4,1
Fukushima ...	21,6	Shidzuoka ...	7,4	Ishikawa ...	4,0
Nagano ...	21,4	Shiga	7,3	Miyazaki ...	3,5
Saitama ...	15,6	Hokkaidō ...	7,1	Wakayama ...	3,3
Tōkyō	15,0	Miye	6,8	Nara	3,0
Yamagata ...	14,6	Hyōgo	6,4	Ōita	3,0
Kanagawa ...	14,4	Fukui	5,4	Kumamoto ...	2,8
Gifu	13,9	Tokushima ...	5,3	Ehime	2,7
Miyagi	13,5	Chiba	5,0	Kōchi	2,0
Kyōto	10,3	Niigata	4,6	Okayama ...	1,9
Aichi	10,0	Tochigi ...	4,6	Kagoshima ...	1,9
Tottori	8,1	Toyama ...	4,4	Yamaguchi ...	1,4
Saga	1,2	Kagawa ...	0,9	Ōsaka	0,4
Hiroshima ...	1.1	Nagasaki ...	0,6	Okinawa ...	0,1
Fukuoka ...	1,0	Aomori	0,6		

I. The Varieties.

On account of the fact that wild mulberry trees are found in the Hokkaidō, the island of Hachijō and the Lu-chu group, Japan is thought to be one of the lands where the mulberry grows naturally.

The variety most widely cultivated now-a-days, is one of the white mulberry species, the Morus alba, according to the classification by De Candolle but all kinds are indigenous except the Rosō transplanted from China. Although over four hundred names of mulberries are found, there are not a few synonyms in the lists, owing to local nomenclature.

These are practically classified into three varieties, *early*, *middle* and *late*, according to the period of budding. The *early* varieties are used to feed the silkworms of the first and second age, because they bud earliest among others and their leaves harden also earliest. Those which belong to this variety and are most widely cultivated, are as follows:—

Fushi-nagari, Ichi-bei, Tago-wase, Yanagi-da, Shiro-wase, Ō-chirimen.

The middle varieties bud in the middle between the early and the late season and serve to rear the silkworms of the third and fourth age. The following are the important ones among these varieties:—

Komaki, Kumon-ryū, Hiko-jirō, Tsuru-ta, Akagi, Rosō.

The late varieties bud latest among the three and supply their leaves chiefly to the fifth age worms. The principal varieties belonging to this class are as follows:—

Nezumi-gayeshi, Jiū-monji, Yamanaka-takasuke, Hosoye, Yotsume, Obata.

II. The Modes of Propagations.

There are four modes of propagations commonly practised: Seedling, grafting, cutting, layering. Each mode has different modifications as follows :—

- Seedling
  - Summer seedling
  - Spring seedling
- Grafting
  - Branch grafting
    - Cutting grafting
    - Splice grafting
  - Root grafting
    - Cutting grafting
    - Splice grafting
- Cutting
  - Common cutting
  - The *Kina-ki* method
  - The *Sudare-buse* method
- Layering
  - The *Shumoku-dori* method
  - The *Yoko-buse* method
  - The *Karakasa-dori* method
  - Mound layering

A. Seedling.

By seeds, we may obtain a new variety which has different characteristics from the original and often tends to degenerate into the wild variety. It is not profitable to propagate the plants by means of sowing seeds, on account of the waste of time, but by this method growers may sometimes set not only plants superior to the parent-stock, but if they use the plants as

the stocks of grafts, healthy and long lived specimens may be obtained. On account of the latter advantage this method is popularly practiced in some districts.

In the practice of this method, well ripened berries are collected from the end of April to the middle of June. Then they are soon planted either by rubbing them against each other, mixed with ashes or fine sand, or by taking off their pulp and washing them in water. Sowing seeds in the same year that they are gathered is called "*summer seedling*." The seed, washed in water as described above, are well dried in the shade, placed in a box or a dry straw bale and buried in a dry sandy soil. The next spring they are taken out and sown. Thus this method is called "*spring seedling*," the seeds being preserved and sown in the next year, after their production. On account of the fact that the power of germinations is injured in seeds preserved a long time, *summer seedling* is widely practiced. A seed bed has been beforehand tilled and manured. The surface is leveled down, covered with earth, and then seeds are sown in the proportion of one or two grains per one-tenth foot square.

Then the seeds are covered with soil, and straw is scattered over them for protection from dryness. Especially when the weather is fine and dry, water is splashed over them both morning and evening to keep the proper moisture. When the seeds germinate, the straw is taken off and a fence, about two feet in height, is made round the bed and a cover is spread over it, when the sun shines or when it rains heavily, the young plants are well taken care of to keep them from injury.

At the beginning very dilute liquid manure is applied to them but the concentration should be made stronger as they grow on. When their height is two or three inches, thinned out and weeded. Afterwards they are gradually reduced in number, until the distance between every two plants is some five or six inches. Thus the plants will grow on from two to three feet in height by the close of autumn, when the leaves fall.

B. Grafting.

The well grown and vigorous shoots are selected as scions. Then with their terminals and roots are cut off and only their middle parts are used. There are three different periods of cutting, (1) shoots are cut off after the fall of the leaves and before the autumnal frost, and preserved until the next spring; (2) shoots are cut off about 10 days before grafting and preserved by stricking them in potatoes or radishes; (3) they are cut off at the time of the actual grafting. The first and second method are widely practiced but the third but rarely, owing to the fact that the scions take up the juice of the stock with difficulty, when they contain too much sap in themselves and good results can scarcely be obtained. Grafting is practiced about two or three weeks after the buds have begun to develop. The grower should take special care of the following two points in grafting, namely, (1) that the cut surfaces of scions and stocks are flattend, both the cambiums and the barks of each should be brought so closely into contact that both air and water may be completely excluded, so that it can not enter into the inserted part, (2) that the shoots, with the short internode,

which have two to three buds, and are about two to five inches in length, serve as scions. Stocks are cut off from two to five inches in length, and grafting is practiced on the smooth surface, where the texture of the bark is not disturbed. Soft straw, after being soaked in water overnight, is used to tie up the inserted part.

a. Branch Grafting.

1. Cutting Grafting.

The proper stocks, having been selected beforehand, are cut off three or four inches from the terminal part when an extended period of fine weather seems probable. One part of the bark, with the small wood, is cut off with a sharp knife and the cut surface is made smooth. A scion, having a smooth and even cut, is inserted in this part. The fit should be so complete as to contact close and firm in all parts and be bound together so properly as not to move. Then the grafted plants are transplanted to a seeds bed.

2. Splice Grafting.

This grafting is practiced commonly in case where stocks and scions are of a same size. For this purpose both are cut off and the cuts are made of the same size and the same form. Then they are placed in close contact and bound together in the same manner as the previous method.

b. Root Grafting.

"*Root grafting*" is practiced when stocks are wanted. This method can not be distinguished from "*branch grafting*" except

that roots are used in the place of the stocks. Roots are dug out and cut off five or six inches long and shoots, prepared with two or three buds, are grafted to them by "*cutting grafting*" or "*splice grafting*" according to the size of the roots.

C. Cutting.

This is a method to propagate mulberries by taking advantage of the fact that the plants are capable of producing a new individual by divisions. Cuttings are generally more easily prepared from the shoots which are in the low part, and have a short internode or are in an oblique position, than by those in the opposite cases and they are always taken off beneath a node.

a. Common Cutting.

There are two ways in this method, namely, shoots are either cut off about 10 inches long in early spring, when the buds have not yet developed, or they are preserved until the spring planting after cutting them between the late autumn when the leaves fall and the early winter. The latter method is most widely used because the cuts will by that time have been quite cured and the cuttings will strike root vigorously. For the preserving of the cutting, a pit seven or eight inches in depth, is dug out in a sandy, well-drained and shady place. The cuttings are placed in it layer by layer, covering each layer with sandy soil one or two inches deep until the pit is filled up. A mound of earth is drawn up over it and the surface is covered with straw or straw-mats to keep in the moisture. The farms for the planting of cuttings are deeply tilled and manured. Ridges, three or four feet wide, are made on which holes are

opened, sloping towards the south, with a stick, having the same size as the cuttings. They are inserted in the holes so deep that only two buds will be above the surface of the ground. Their bases are hardened; straw and dry hay is scattered over the fields to protect them from drought. When the buds grow one or two inches long, other buds are taken off, leaving only a single, most vigorous one in every cutting. The dilute manure is sprinkled near the base of the plant and the earth between the ridges, is drawn thickly to it as the bud grows. Thus we will have plants, five or six feet in height, until the close of the autumn.

b. The "Ki-maki" Method.

In the early part of July, the new shoots, over three feet high, of the "*bush planted*" mulberries (*negari-kuwa*) are turned down on the ground and buried with earth or straw, leaving their terminal parts remaining, about six inches long, upon the surface. After the leaves fall, the shoots, bleached in the earth, are taken out, and after being cut off some four or five inches in length are placed in dry soil until the spring. In the other way, the shoots are taken out in the coming spring and cut off. In both cases, the cut shoots are planted, until the budding commences in the spring. For this purpose, seed beds have been prepared beforehand and ridges, two feet in width, are made, on which small trenches, four or five inches wide, are dug out. The cuttings are laid in them in an oblique position, keeping them five or six inches from each other when they are covered with fine soil, so that their terminal parts are not exposed.

The soil over them in trodden down slightly, straw is scattered over the whole, to protect the plants from the damage caused by dryness, wind and rain. When buds grow three or four inches, dilute liquid manure is applied and afterwards they are nursed as described before.

c. The "Sudare-buse" Method.

This method is practiced on buds in the spring. On the farm, tilled and manured, trenches, about eight inches deep, are opened, so that they are from three feet and six inches to four feet from each other. The soil is heaped up on both sides. One end of the cutting, one foot and three inches to one foot and nine or ten inches in length, is put into a mound on one side of the trench, as deep as three or four inches and the other end is placed in the other mound on the opposite side. The distance between every two cuttings is about four or five inches. The exposed part of the cutting is covered with bamboo leaves, straw or green grass to protect them from dryness. Dilute night-soil is applied occasionally. When the young shoots grow to be four or five inches high, all of them, except two, are taken off, and afterwards earth is drawn up two or three inches high, when these two shoots are six or seven inches in height. Thus we will get the young plants some five or six feet high, by the close of the autumn. They are taken out in the autumn or the next spring and transplanted in other fields, after cutting them in the middle into two parts if they have two new shoots.

D. Layering.

In this method, roots are made to spring out from twigs or

branches by burying them completely or only their middle parts in the soil, or by drawing earth to the bases of new shoots, turned down to the ground, and then when they have sprouted, they are separated from the mother plants, as individuals.

a. The "Shumoku-dori" Method.

For practicing this method, all the branches of a *bush planted* mulberry are taken off in the middle of April, leaving only three or four straight and vigorous ones which have a moderate size. When the buds grow three or four inches high, trenches, three or four feet in length and four inches in depth, are opened in the place where they are laid, in which fertile soil is set. The earth surrounding the trenches is made to be three or four inches higher than the surface of the ground. Then the shoots to be laid down, are cut off three or four inches in length at the terminal parts and bent, so as to turn them stemward. Thus the downward buds are got rid of. At first the twigs are fastened down at a distance of about one inch above the ground and after one week, they are brought in contact with it, then earth is drawn up to them, by using a rich soft soil. Afterward they are top-dressed with dilute liquid manure in the latter part of June and the shoots are covered with earth to the depth of one or two inches, at the same time an incision is made at the bent part of the shoots, one or two inches long, by partly stripping off the bark. In the middle of July the plants are again manured, earth is drawn up to the depth of one or two inches and the bark is again stripped off, leaving only a small part which will be completely stripped of bark at the end of the month. In the close of the autumn, the shoots are taken

out when the weather is fine, and are cut off into something like a knocker shape, which serve as sprouts.

b. The "Yoko-buse" Method.

This method is popularly practiced in some districts of the prefecture of Shiga. According to this method, new sprouts are obtained from those of the previous year, without using the old stock as in the preceding method. For this purpose, a well-drained and fertile bed, which has been thoroughly cultivated, is used, and vigorously rooted sprouts, without cutting their terminal parts, are planted on the ridges, which are about three feet wide, sloping them about 40 degrees and keeping them some four or five feet from each other. When buds develop about one inch, the shoots are brought down to the ground and the buds are reduced so as to have, say, one in every six or seven inches of the shoots. On the buds turning straight, their bases are covered with earth. Afterward they are treated just as in the preceding method, and thus new plants are produced at the close of the autumn.

c. The "Karakasa-dori" Method.

In order to practice this method, branches are cut off before budding and earth is drawn up to the bases of the mother trees. When new shoots grow from one foot and six inches to two feet, radiate trenches, less than five inches in depth, are opened round the mother trees. At the bottom of the trenches, well decomposed compost is placed, and covered with earth in a thin layer. Then the new shoots are turned down into the trenches and buried, leaving some four or five

clay and of bad drainage, or when the sandy but poor, the plants should be planted seven or eight inches deep, keeping them two feet and five inches to three feet from each other and the distance between the ridges should be some five or six feet.

Before planting the young plants, their roots are dressed. For this purpose, the number of roots and their future growth are ascertained by looking at their forms. The roots injured by cut or diseases, and those which have no prospect, owing to bad growth, or are of no use, are thrown out. Also the overgrown parts of the roots which are to remain, and any withered and tufty radicles are removed. There are two ways of planting, namely, *Mizobori-uye* (planting in trenches) and *Tsubobori-uye* (planting in pits). The latter may be practiced only when the whole farm is deeply tilled, but otherwise the former is widely used. In planting, the direction and the width of ridges are at first determined according to the features of the fields. Then ropes are streched along the direction, and trenches or pits are dug up to the proper depth and width, in which compost is placed, covering it with earth some two or three inches deep. The earth trodden down slightly, the young plants are laid in and their roots are put in the proper position. Then the planter holds the shoots upright with one hand and covers the roots with dry, fine soil, gathering it up with other hand. The plant is moved slightly and then the earth is trodden down. Again the soil is drawn up some four or five inches deep, in shape like an inverted basin. In "*planting in trenches*," the earth on the foot of the plant, is leveled down with a spade, after finishing, the operation. If the shoots

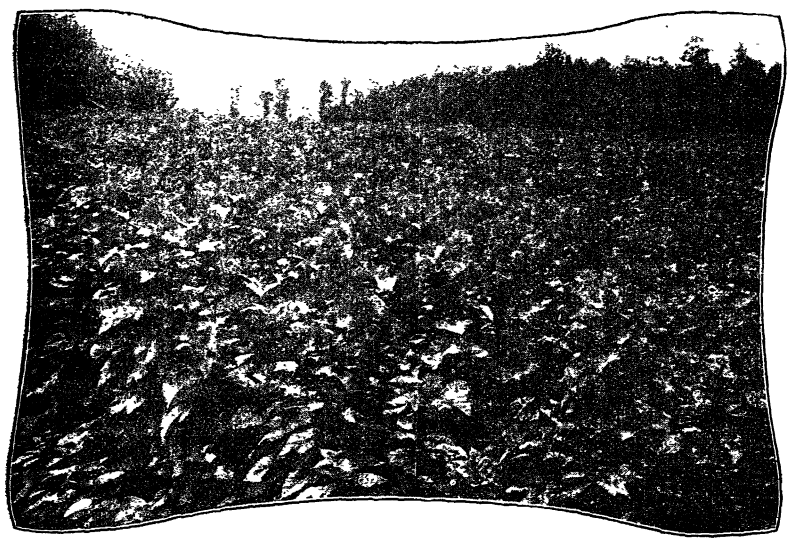
have not been cut off beforehand, they should be taken off with a sharp sickle soon after planting. At first, the trenches or pits are filled, leaving some four or five inches under the surface of the ground and gradually leveled up, as the buds grow, by putting in the earth some two or three times, which serves at the same time as weeding. After transplanting, the mulberries are pruned in various ways and so trained as to facilitate their cultivation, their management, the gathering of the leaves and the forcing of the growth. Thus the methods of plantation are generally classified as four :—

The bush plantation (*Negari-jitate*).
The dwarf-plant plantation (*Chūgari-jitate*).
The high-grown-plant plantation (*Takagari-jitate*).
The full-grown plantation plant (*Kyōboku-jitate*).

The fourth consists of many ways among which the "*Akita method*" is widely used and is thought to be a good one.

The "bush plantation" (*Negari-jitate*): Many disadvantages are caused on account of that in this method, mulberries are planted close to each other and many shoots are made to come out from the stock by cutting them off on a level with the ground every year, that is to say, it is inconvenient to manure and cultivate them; the leaves of the lower part of the stem are almost all stained; the damages caused by frost and snow are most severe; and the plants get easily attacked by *rachitis* and are soon decayed. But this method has the following advantages at the same time; the plants grow

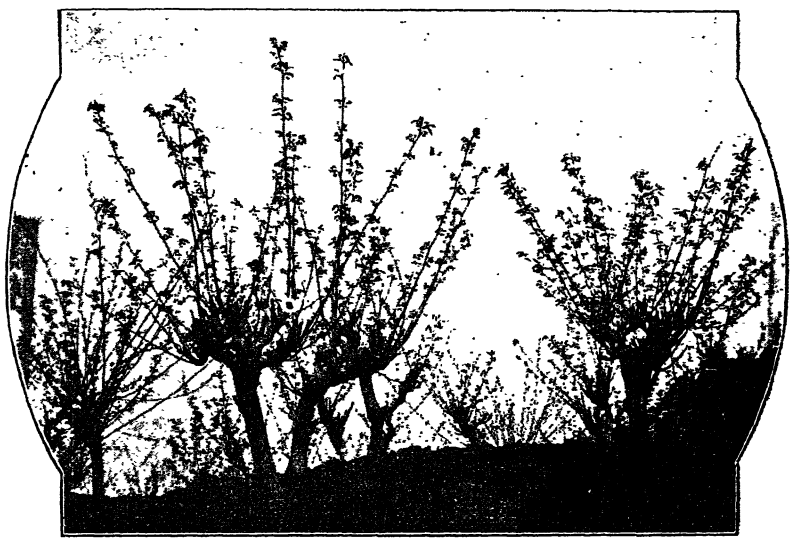
quickly and yield a crop in a short period; the leaves are soft for a long time; it is convenient for gathering them and other management and there is less fear of insects and fungi which are



THE "DWARF MULBERRY PLANTATION" (*Negari-jitate*).

easily driven off even in the case of their attack. For these reasons, this method is popularly used in level districts. According to this method, 600 to 900 mulberries are planted per *tan*. They are well manured and should not be harvested in the year when planted. In the following spring, the shoots are cut off before the buds develop, leaving one or two of them. Then they should be well manured and cultivated as in the previous year. In the third year, the leaves may be supplied to the annual silkworms and in the fourth, the plants will yield an ordinary crop.

The "dwarf-plant plantation" (*Chūgari-jitate*): This is popularly practiced in the prefectures, of Fukushima, Gumma and Tōkyō. According to this method, 400 to 700 mulberries are planted per *tan*. All the buds, except certain vigorous one, which have come forth in the next spring after plantation, are removed and manure is sufficiently applied. Before budding in the spring of the second year, the plants are cut off one to three feet above the level of the ground and two or three buds



THE "HIGH-GROWN MULBERRY PLANTATION" (*Chūgari-jitate*).

on the end are made to grow. Then the plants are carefully nursed as in the previous year. In the third year the leaves may be gathered and supplied to the spring silkworms. From the fourth year we will have an ordinary crop.

The "High-grown-plant plantation" (*Takagi-jitate*): This is one in which the mulberries are trained to some four or five

feet above the surface of the ground and is widely practiced in the mountainous districts of Gumma and Yamanashi. According

THE "FULL-GROWN MULBERRY PLANTATION" (*Takagari-jitate*).

to this method of plantation, 300 to 500 mulberry trees are planted per *tan*. For practicing this, a single and most vigorous bud is left remaining after transplanting, and the removing of all of the others, and the trees are so managed as we do those in the preceding method of plantation. In the spring of the third year they are cut off some five feet in height; all buds are then taken off, leaving only two or three at the terminus. Afterwards the same management as in the preceding case is performed.

The *Akita method* of plantation: This is practiced in some districts in the prefecture of Akita. Fifty to hundred trees

THE "*Akita*" SYSTEM OF MULBERRY PLANTATION (*Akita-method.*)

THE MULBERRY TREE OF *Akita-method.*

are generally planted in every *tan*, according to this method of plantation. In February of the next year after transplanting, when the buds will not develop, the vigorously grown shoots are cut off about four feet high above the surface of the ground, and weak ones are taken off near this bases. Thus the main trunk is carefully nursed. On the shoots, thus cut off, three vigorous buds are left in a triangular position, after removing all of the others. Until the autumn they will have grown some five or six feet in height. Before budding in the spring of the third year, each shoot is pruned to from some two to two and a half feet in length, but the weaker ones are shorter. Again two or three vigorous buds are left on each shoot after taking off all the others. Thus in the autumn, the height of the shoots will be over six or seven feet. In the fourth year, the shoots are cut

off to the height of one foot and five or six inches and again two or three buds are left on each of them, which will grow some five or six feet until the autumn. Thus the mulberry trees are pruned and trained until we finish the operation in the fifth year, and we may gather an abundance of leaves in the sixth year.

As described above from the year of transplanting to the sixth, the trees are pruned in the spring but in the seventh, in the summer. After this, spring and summer pruning are alternately performed. We call it "*summer pruning*" inasmuch as that after the developing of the leaves, shoots are cut off, leaving some one or two inches in length and the leaves are applied to rear the annual silkworms, and "*spring pruning*" is that in which shoots are pruned in the middle of February in such a way that the mature or woody shoots are cut off shorter than the unripe ones and the leaves of the new shoots are gathered to feed the *summer silkworms*.

IV. CULTIVATION.

The mulberry farms are cultivated generally three times, beside tillage for manuring or weeding, namely :—

The first time.....about one month before budding.
The second time.....soon after the gathering of the leaves
The third time ..... after the fall of leaves in the autumn

But when the soil is moist or lumpy, owing to heavy clay one more tillage is necessary at the end of September or in the beginning of October.

The first or spring tillage is in general done by means of the "*level tillage*" but sometimes mounds are opened by tilling both sides or one side of the ridge, and earth is drawn to the feet of the the plants. The soil between the ridges is dug out so as to make a small trench which will be gradually filled up in manuring or weeding. The second tillage, that is, the tillage after gathering the leaves, is done by means of *level tillage*, but if it is difficult to practice it or it is not necessary owing to the light soil, the earth between the ridges is dug up deeply by tilling both sides of the ridge and afterwards the opening is filled up when the trenches for manuring are prepared. The third, or autumn tillage is done by tilling one or both sides of the ridge. The earth on the bases of the plants is piled up between the ridges. The fourth tillage is performed between September and October and the methods of cultivation are changed, according to the conditions of the farms. In the case of level fields, they are cultivated in a shallow manner, by drawing the earth to the feet of the plants, and if there are any ridges, they are leveled down.

The depth to be tilled varies, according to the hardness of the soil and the depth of planting, but as a general rule, about one foot is the standard, except in the fourth tillage, and in the spiring, summer and autumn tillage always the same depth is held. Weeding is practiced rather rarely, because weeds are hoed down, in cultivating and manuring practically they are weeded once or twice from midsummer to autumn. For this purpose, in the wet and stiff clay soil, they are buried by spading over the surface soil not deeply while in the sandy soil, they are picked out or cut down with a sickle.

The manures are nitrogenous and late-acting in many cases, on account of the fact that the mulberry is a perennial crop and requires less phosphate and lastly the soil in Japan is in general rich in potassium salts. The fertilizer which is most widely used, is the compost, consisted of night soil, horse dung, the litter of the silkworms, straw, weeds, fallen leaves and dust. Besides which, there are not only the commercial fertilizers, but also soybean cakes, herring refuse, *Shōchū* refuse, ammonium sulphate, chili saltpetre, *Saké* refuse and *Shōyu* refuse are also popularly in use. The manure is applied generally at the following two seasons :—

The first time.....in the spring after the first tillage.

The second time.....in the summer after pruning or gathering the leaves.

The fertilizers are in many cases given between ridges or stocks and the depth of the manuring is the more variable, according to the properties of the manures and the soils than that of planting, say, eight or nine inches to about one foot for a clay soil and compost or farm yard manure ; three or four inches to six or seven inches for a sandy soil and a liquid or quick-acting manure. In all cases, the manure is applied in the small trenches which are soon filled up with earth. In the cutting of the mulberries, shoots should be taken off close to the stock, without leaving any foot to them, but farmers are so busy in the time of gathering leaves that they are not capable of practicing such careful treatment. For this purpose, the shoots are taken off somewhat higher and are afterward cut off again in the proper position. This operation is done at midday when

the weather is fine, within a week after cutting, by taking off the shoots also to the stock with a sharp sickle and so leveling and smoothing their cuts as much as possible. The cutting is so operated that the outside buds on the bases of shoots, are made to develop, for the purpose of setting many shoots spread outwards from the stock. The pruned shoots of mulberries are bound together during the winter. This is because the shoots are kept from drooping, the surface of the ground may receive such an abundance of sunlight, that the soil would be warmed and dried, the shoots are kept from being broken by snow and the damage, caused by the late frost, is lessened. At the close of the autumn, when the weather is fine, the low part of the shoots is loosely bound together, then after the leaves fall, their upper part is also bound together at two points, and the time, when their ties are unbound, is from the finishing of the spring tillage and manuring, to that of budding.

V. Crops.

The period of gathering the leaves and cutting the shoots is changed, according to that of the rearing of the silkworms, but generally it is as follows :—

For the rearing of the spring breed,—both the gathering of the leaves and the the pruning of the shoots are undertaken in the spring.

For the rearing of the autumn breed,—in the spring the shoots are pruned before budding and in the autumn the leaves are gathered.

PLUCKING OF MULBERRY LEAVES.

For the rearing of the summer and autumn breeds,—in the spring the shoots are pruned before budding and the leaves are gathered in the summer and autumn.

For the rearing of the spring and autumn breeds,—in the spring, the leaves are gathered and the shoots are pruned, in the autumn the leaves are again gathered.

For the rearing of the spring, summer and autumn breeds,—in the spring the leaves are gathered and the shoots are pruned, in both summer and autumn, the leaves are again gathered.

When we gather the leaves and cut off the shoots in spring, it is always to collect the leaves only until the fourth age of the silkworms, but afterwards the shoots are cut off little by little, in order to rear the silkworms of the fifth age with them, without plucking off the leaves.

The yield of the mulberry varies according to the fertility of the soils, the ways of cultivation, the varieties of climate, the varieties of the mulberry and the management, but the usual crop in the *bush-plantation* is about 600 *kwan* of the shoots, including their leaves which are about 200 *kwan*, in every *tan*.

The results of the experiments conducted by the Tōkyō Sericultural Institute, concerning the comparative crops of the early, middle and late mulberry leaves per *tan* respectively, gathered in the proper periods are shown below :—

		Kg.
Early Varieties ...	For the first age	146,851
	For the second age	367,183
Middle Varieties...	For the third age	485,401
	For the fourth age	633,613
Late Varieties.....	For the fifth age	934,728

In the same institute, the crops, concerning the different varieties are also investigated with the following result :—

Early Varieties.

	the number of stocks	the weight of the leaves	the weight of the stems	the weight of the shoots	total	the average weight of leaves in one stock
		g.	g.	g.	g.	g.
Shiro-wase...	48	36,507.	14,117.	89,456.	140,080.	751.
Fushi-magari.	63	45,599.	17,211.	82,386.	145,196.	718.
Tago-wase...	68	422,701.	19,614.	92,836.	159,151.	684.
Ichi-bei	64	46,573.	15,241.	88,622.	150,436.	725.
Ō-chirimen...	69	28,44c.	11,078.	63,574.	103,093.	412.

Middle Varieties.

	the number of stocks	the weight of the leaves	the weight of the stems	the weight of the shoots	total	the average weight of leaves in one stock
		g.	g.	g.	g.	g.
Kumon-ryu..	41	50,356.	14,536.	61,792.	119,164.	1030.
Rosō	39	52,966.	15,748.	92,035.	160,749.	1334.
Tsuru-da ...	51	58,576.	21,090.	83,215.	162,881.	1140.
Aoki	59	49,652.	20,412.	80,512.	150,576.	801.
Akaki.....	36	60,754.	22,658.	83,683.	167,195.	1677.

Late Varieties.

	the number of stocks	the weight of the leaves	the weight of the stems	the weight of the shoots	total	the average weight of leaves in one stock
		g.	g.	g.	g.	g.
Nezumi-gayeshi ...	73	63,974.	27,604.	98,335.	189,913.	865.
Jyumon-ji ...	69	67,806.	27,246.	102,371.	197,424.	974.
Kobata	46	53,866.	23,528.	84,927.	162,321.	1171.
Yotsume ...	81	56,191.	23,615.	86,298.	166,104.	690.
Yamanaka-takasuke..	52	55,934.	20,084.	78,943.	154,961.	1069.

VI. The Injuries to the Mulberries caused by Insects, Diseases and Frost.

A. The Diseases of the Mulberries.

There are different kinds of diseases, namely, mulberry-dwarf-trouble and many diseases, caused by parasitic fungi. Now we will describe briefly these diseases:

1. The Mulberry-dwarf-trouble.

This disease is characterized by the sprouting of many feeble shoots from the stock, after their being cut off for their

leaves, by the shrinking and wrinkling of the leaves on the shoots, and by the fading of the leaves into a pale green for the want of their normal amount of chlorophyl. Some of the varieties liable to be attacked dy this trouble, while others are not, but in general, *Negari* mulberries (the kind of the mulberries cultivated as bushes) are more liable to be troubled by this disease than *Chūgari* and *Takagari* mulberries (dwarf and high-grown-planted mulberries). This disease is caused physiologically by the want of the preserved nutrients, especially nitrogen, in the stock, on account of the cutting off of the shoots while they were growing vigorously. The only cure for the disease is to select the healthy varieties and to gather their leaves and shoots properly.

2. "Mompa" Disease.

This disease is caused by the parasite, called the Stypinella purpurea (Tul.) Scbr. In many cases, the mulberries in the farms which are newly prepared by breaking up the forest land, are attacked, but in the old farms, the disease is found only in a damp soil. On the roots of the diseased plants, one finds the filament entangled like vines which will cause the roots to decay, and a mass of purple and vein, like filaments, on the base of the stocks. The remedy is to open a deep ditch, because this disease is an infection of the roots caused by their having too much moisture.

3. Pourridie.

The cause of this disease is the parasitic growth of a fungus, called Dematophora necatrix Hartig. The fungus shows itself

in the shape of white flakes, like a cotton cover, on the roots which will be soon decayed and then the trunks will die. When the mulberry plants are attacked by this disease, it is better to pull them up at once and burn them.

4. The Agaricus mellens.

This is a disease, caused by a parasite, called Armillaria mellea Vahl.. The roots of the diseased mulberry rot greatly, then their leaves become yellow and soon fall, and at last their trunks die.

5. Bacteria Disease.

This disease is caused by a bacteria, called Bacillus cubonianus Macch. Both the branches and leaves are attacked, especially, the trunk of the diseased mulberry rots into black and finally dies. The shoots of the *Negari* mulberry are injured in many cases and also those of the *Takagari* mulberry are often attacked in the districts, where the mulberries are often damaged by severe frosts.

Beside those described above, there are several kinds of fungi which are the parasites of the mulberry and cause several diseases: namely, Septobasidium pedicellatum (Sch.) pat., Scherotinia libertiana Fuck., Septogloem mori Bris. et Cav., Aecidium mori (Barch.) Diet., Phyllactinia corylea (Bas.) Karst., etc.

B. The Injurious Insects of the Mulberry.

There are many insects injurious to the mulberry, now we will describe in short about the very most injurious ones among them in the following pages.

1. The Scale Insect of the Mulberry

(Diaspis pentagona Targ.).

This insect dwells on the trunk of the mulberry and lives on the sap of the tree to its great injury. The distribution of the insect in wide and it injures the *Negari* mulberry and also the *Takagari* one. The female insects attach themselves closely to the branches or the trunk, concealing themselves under the scales where they secrete themselves and live on the juice of the tree, by sucking it with their long rostrums stuck into the bark. They lay eggs in the scales and the larvae which come forth from the eggs are distributed over the branches. The larvae which are female, attach themselves to the bark and secrete the scales, and those which are male, spin white and elongated cocoons in which they are metamorphosed into chrysalids. Then the winged male insects come out from the cocoons to couple, inserting their generating organs into the scales of the female. Thus the insect reproduce its kind thrice a year. In order to protect the mulberries from this insect, we examine, whether the young plants have any scales of the insects or not and get rid of them, if there are any. The mulberry farms should be always made to be so far as is possible exposed to sunshine. If the farms have been once attacked by the insects, they should be scratched with a bamboo spatula and the insects killed during the winter, if this is insufficient, the syringing with kerosene emulsion, kerosene and the mixture of lime and sulphur are recommended.

2. Leafrollers.

There are several kinds of these insects among which the Archips crateagona Hb. and Exartema mori Mats. are common in their injury to mulberry plants. Both of them injure the buds of the mulberries in the early spring. In the middle of May they roll the leaves by sppinning in which operation the insects become pupae. The small moths come forth in June and lay eggs on the slender shoots. The pupae of the insects are often killed by a parasitic bee.

3. Hemelophira atrilineata Butl..

This insect dwells on the mulberry through all seasons and lives on the buds and leaves. Especially, the insect injures greatly the young buds in the spring time. The larvae are grayish brown and just like a dead twig. When fully grown, the insect is 60 mm. in lenghth. The anterior part of the body is small, while tha posterior becomes gradually greater. The thoracic legs are composed of three segments, while the abdominal has two. The insects mature from the middle to the latter part of May, then they are imprisoned within oval, pale brownish and coarse cocoons, that are spun in the crevices of the trunk or on the base of the tree, in which the insects change into a pupa. After about one week, the moths appear and lay eggs on the mulberry leaves or branches which will be hatched about three weeks afterwards. The growth of the insects is sometimes quick and sometimes slow and they are either divoltini or trivoltini. The insects are easily destroyed from winter to early spring, when the larvae stick themselves on the branches like dead

twigs. Here we add that the insects have a parasite called *Kamodoki-bachi* (L. Logas sp.).

4. Aprione regicollis Chevr.

This insect injuries the mulberries in both periods, that of the larva and that of the imago. The larvae saw their way into the trunk of the mulberries, especially, *the high-grown-planted mulberries* and dwell in the wood. After two or three years, they become mature. The injured trunk is retarded in its growth, or killed outright. The mature insects deposit eggs in June or July under the bark of the shoots which they turn up by biting. The injured shoots are after broken down by the wind. The imago is one of the large coleopters, 37 mm. in length and a pale green in color.

Their eggs are elongated ellipses of a light greyish white and their longer diameter is 2,4 mm.. The full grown larvae are 60 mm. in length and of a pale yellowish white color. Its head is a dark brown and it has strong mandibles which are quite proper for biting. The method for destroying them are either to pour the insecticide into the holes of the wood which are made by the insect or to stab the eggs on the branches. The eggs have, as an enemy, a parasitic bee which I should be propagated for their destruction.

There is also a small coleopter, called Clytanthus cubineusis Chevr., which injures the mulberries in a similar way. Beside those described, the important insects, injurious to the mulberries, are as follows:—

Anomoneura mori Sehw. (*Ki-jirami.*)
Glyphodes pyloalis Walk. (*Suki-mushi.*)

Diacrisia imparilis Butl. (*Su-mushi.*)
Porthesia similis Fuessly. (*Kinke-mushi.*)
Phyllotreta funesta Baly. (*Himeha-mushi.*)
Baris deplanata Roel. (*Himezo-mushi.*)
etc..

There are two animals that are injurious to the mulberries besides these insects, one is a slug and the other a field mouse. The following is a brief description of them.

5. Slugs.

The slugs injure the mulberries cultivated after the *bush-planted* mulberries by eating their buds, which come out after the leaves have been plucked. They live in a wet place along a stream. This kind of slugs is called Limax agrestis L.. For protection from the slugs, the dust of quick lime may be scattered about on the farms in the evening.

6. Field Mice.

The mice eat during the winter the bark of the mulberries, gnawing the cortical layer of the root to the woody part, until the tree will die at last. This kind of mice is called Microtus montbelli M.E. and they live in every district. During the winter, when the mice can find no food in farms, they do injury to the mulberries; especially in the snowy districts the injury is serious. For killing the mice, Mereskowskys bacillus is practically employed.

C. Frost Damage.

The mulberry leaves are often damaged by the late frost,

after the buds have developed. The frost damage is either severe or light, according to the climatical conditions of the years or the districts, sometimes there is no fear of the damage. In the nothern part of Japan, frost damage has been caused hitherto once in three or four years. The damage is caused by the freezing of the young buds and leaves to death. The frozen mulberries show such a wretched conditions that they have no green leaves but only black. A good method for protecting the mulberries from frost, is esteemed to be the smoking of the mulberry farms, otherwise there are no means except that of wrapping up the shoots with straw or matting, or covering the leaves with these means of protection against the extreme cold.

CHAPTER VI.

THE FEEDING OF SILKWORMS.

I. The Varieties of Silkworms.

The silkworms, reared at present in our country, are only a single species of the insect considered from the point of zoology, but through natural and artificial selections for many centuries, a large number of varieties have been established. These innumerable varieties are classified according to the number of 'crops' in a year as follows:—the annuals, the bivoltines and the polyvoltines. The annuals produce one brood, the bivoltines two broods and the last more than three broods in a year. Among these varieties the annuals are conceded to be the most profitable for silk growers on account of producing the greatest amount of silk for a certain quantity of the mulberry leaves given to them, the bivoltines produce the middle amount of silk, and the last the smallest; while in feeding, the polyvoltines are the most vigorous and the easiest to be reared, the bivoltines are next and the annuals are rather difficult to be fed. In other words, the varieties which produce the great amount of silk for a certain quantity of the mulberry leaves taken by the silkworms are weak, and those of the opposite sort are vigorous.

Varieties are often named after the colorations of their cocoons, namely, the white, yellow and green cocoon varieties. Those which are reared at present in our country, are chiefly the white cocoon variety. Although the green ones were papularly

fed formerly on account of their being healthy, now their feeding is very rare, owing to their producing an inferior grade of raw silk, which has not a bright lustrous tint. The remarkable differences between the qualities of the filaments of three kinds of the cocoons can not be found, but from the results of the comparative investigation concerning the boiling off of the raw silks reeled from these cocoons, we may conclude that the raw silk from the white cocoons has the least boiling off, while the others have the greater. Still from the numbers of the moults during their life-periods, the silkworms are classified into two kinds, that is, three moults worms and four moults ones. The former moult thrice from the time of hatching to that of spinning a cocoon, and the latter four times during the same period. On account of the fact, that the latter worms produce a large amount of the better grade of silk, although they have longer 'cycles' than the former, they are widely reared, while the former are very rarely. Lastly, according to the seasons of the cultivation, the worms are classified into the *spring*, *summer* and *autumun* breeds. Though this classification is popularly used, it does not mean that they are different varieties, but only shows the different seasons of their feeding. The *spring* breed is allowed to hatch after the budding of the mulberry trees, the *summer* breed soon after the "*mounting*" of the spring worms and the autumn at about the commencement of the autumn, say, from the former part of August to the middle of September. The silkworms reared in spring, are almost all annuals, but according to colorations, sizes, markings, and the shades of colors on the body, and whether the cocoon is large or small, long or short, oval or round, and whether its granulations are coarse or

not, various names are given as follows:—*Aka-biki*, *Ao-biki*, *Mata-mukashi*, *Koishi-maru*, *Tsuno-mata*, *Kasuri*, *Hime-ko*, *Kuna-ko*, etc. Besides the above, several hundreds of the races may be found, but those which are widely reared for practical purposes, are only two or three races, namely, the *Ao-biki*, the *Mata-mukashi*, the *Koishimaru*, and the *Shira-tama*, which are healthy, easy to feed, comparatively productive, and moreover produce good silk.

The silkworms fed during the summer and autumn are the annuals, bivoltines, hybrids obtained by crossing the former two races and rarely polyvoltines. So there are many names of the races, but only *Haku-ryū*, *Kasuri*, and *Yanoha* are widely reared, being conceded to be the superior ones.

It is general that the silk produced by the summer and autumn worms, is inferior to that of the spring. Formerly the annuals were commonly reared while the summer breeds were reared only in a certain district, and even those summer breeds were nothing but the second generation of the so-called bivoltines. But about 40 years ago a method was invented, by which the grains of the second breed of the bivoltines were preserved in a cool storage, and by this means the first breed is made to hatch in summer and the second breed in autumn. Thus we achieve the ability to rear the autumn breed. The season of the feeding of the new worm is suited to the leisure of the farming classes, and by this rearing of silkworms they may conveniently distribute their labours. On these accounts, the new genesis of the worms was welcomed by the sericulturists. The invention of the autumn breed has made active progress during a short period.

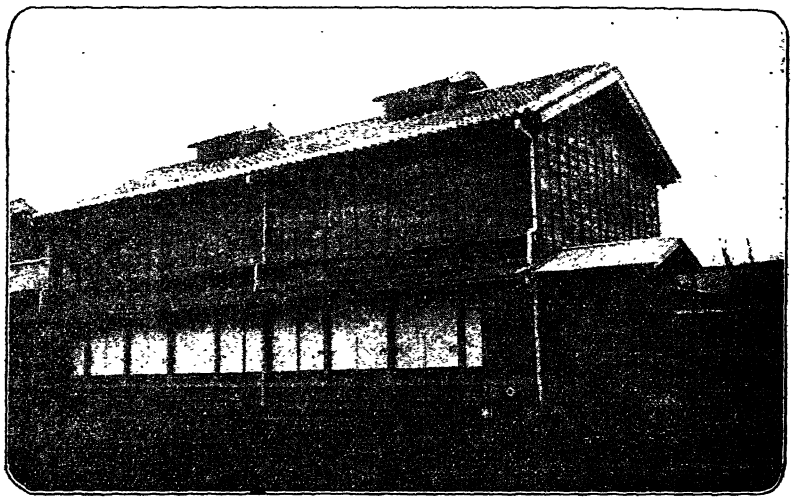
A natural cold cave, called *Fūketsu* has been found in every district as a storage for the eggs of the annuals and bivoltines, which are taken out and hatched at any times, as one pleases, from spring to autumn. Thus silkworms may be fed several times a year. It is said that the fact that the recent sericulture in our country has brought forth such prosperity, is greatly due to the discovery of *Fūketsu*.

A cave or *Fūketsu* is often found in a rocky place in the volcanic districts. Cold air is always blowing in a *Fūketsu* through the crevices of the rocks and the interior temperature is so low that even in the hottest day of summer it is kept below 40 degrees F.. When the eggs are preserved in this cave, their nuclei are in the same dormant state even in summer or autumn that they are in winter. If the eggs are taken out and kept at a temperature of over 70 degrees F., they will hatch after one or two weeks.

II. The Silkworm Rearing House and Instruments.

As the sericulture industry in Japan has been practiced in general case as an accessory occupation of farmers, many of them have reserved one part of their dwellings for the culture of cocoons, and except a few have not built any special building.

Whether the situation and construction of the silkworm rearing house are suitable or not, has a great influence on the health of the worms, and also the facilitation of the actions, and the amount of the labours of the rearers depend greatly upon them. For these reasons, those who wish to build a silkworm rearing house should select at first the situation properly, and



SILKWORM REARING HOUSE.

then construct the house so completely that it may be hygienic for the silkworms, facilitale the actions of the rearers and diminish their labours.

A. The Situations of the Silkworm Rearing House.

A suitable place for building the silkworm rearing house should be dry, open and airy. On the contrary, the moist, narrow and closed place which is surrounded with hills, forests, houses, etc., is not proper for the building. However as it is impossible on account of the topographical conditions in various places that all the sericulturists in different localities can select the fittest situation for their silkworm rearing houses; therefore, the builders should endeavour to search as carefully as they can for the most suitable place and to compensate for the unavoidable defects of the situation in the construction of the house itself.

For example, when the place is moist, trenches are dug out round the house or stagnant water is drained off by the underground sewers, but if this is impossible, the surface of the ground is elevated for drying, by piling up the earth into a mound. The house is built with a high floor and an upper or third story, so that the damp vapours arising from the ground, are avoided as much as possible and at the same time accommodations for ventilation are arranged. Especially should this be so, when hills, forests and houses are close to it. In short, a dry and airy place is suitable for building the silkworm rearing house and damp sultry place is not proper for such a building. But there is no exception in this case to the universal rule that profit always follows loss. Thus a silkworm rearing house built at the most proper place, may have much profit in view of the fact that the silkworms are easily protected from the unfavourable conditions of the climate, such as hot and oppressive weather, and may spin a good grade of cocoons, which may be easily unwinded in reeling. But at the same time the house has such disadvantages that much fuel is needed to keep the rooms warm in the feeding of the young worms of the *spring* breed, and also the growth of the silkworms is often retarded by the drying of their litters too much. On these accounts, the house is suited for the rearing of the last age worms of the *spring* breed and the worms of the *summer* and *autumn* breeds. On the contrary, although the silkworm rearing house in an unsuitable place, as described above, has rather gloomy rooms and often gets so sultry, in the feeding of the last age worms of the *spring* breed and the worms of the *summer* and *autumn* breed, that their health is at times impaired; on the other

hand, the expenses for fuel can be spared in warming the nursery in the first period of the rearing of the *spring* breeds and also there is but little fear of injuring the silkworms by the overdrying of their litters.

In selecting the situation of the nursery for feeding the young worms of the spring breed, and the mature ones of the same breed, and the worms of the *summer* and *autumn* breeds, the rearers usually consider profoundly the above relations.

B. The Direction of the Silkworm Rearing House.

The silkworm rearing house is in general constructed towards the south, for the reason that the room facing the south has something exhilarating and in its influence is always hygienic and also it is convenient to have a rich full draught of the breeze from the south which is the ordinary wind during the summer in our country, the rooms are easily kept at a moderate temperature, both the left and the right sides of the house being exposed to the rising and setting sunshine; while the house built along the north and south directions, facing towards the east and the west, is so brightened on the front and back side, by the rising and setting sunshine, that in spring the rearers may have the profit of sparing fuel by utilizing the heat caused by the sunshine, but in summer, when the temperature becomes gradually high and fire is unneccessary to warm the rooms, the rearers may often be troubled by a too high temperature, caused by the rising and setting sunshine. Moreover bad ventilation is an unavoidable defect in the nursery, constructed in this direction.

C. The Construction of the Silkworm Rearing House.

There are in general two kinds of silkworm rearing houses, one storied and an upper storied house. Rarely there are three storied houses.

Now we will investigate the advantageous and disadvantageous points of these constructions in the following pages. Only on the point of the facilitation of the actions of the rearers, a one storied house is the best of all, but if space is unsufficent to build it or the ground has too much water or any adjacent obstruction prevents it from aeration, the upper or third storied house, is better. Though a one storied house tends to become somewhat damp, it is convenient at the same time to keep warm. On this account, it is suited for rearing the young worms of the *spring* breed. The upper and third story, being quite dry, such constructions are better than a one storied house as a nursery during the summer and as *mounting* house, but the difference of temperature between day and night being great, they are not suitable to rear the young worms of the *spring* breed.

The inside of the silkworm rearing house is usually divided with walls. The common extent is 12 feet to 15 feet by 12 feet to 18 feet. When the depth is too great, the room becomes so damp and unhealthy for the silkworms that they sometimes fall successively into Grasserie, Muscardine, etc., while too spacious rooms are difficult to regulate in respect to the interior temperature as the rearer wishes and also are not suitable for nursery purposes.

The floor is made two feet in height when the place is

moist and one and a half feet when it is dry. A small window with a door which may be easily opened and closed, is made in various places under the floor. The board of the floor is about one inch in thickness and nailed down so closely each other, because if there are any open spaces in the floor, the regulation of the inner temperature is difficult.

The proper distance between the floor and the ceiling is from eight and half feet to ten feet. If it is too low, the air of the interior becomes musty, while if it is too high, it is difficult to regulate the interior temperature. The windows for ventilation, prepared with a door which is opened and closed by means of two ropes, are made at the four corners and the middle of the ceiling. Their sizes depend on the extent of the ceiling. But the common sizes are that the windows at four corners are about one hundredth and the middle ones about five hundredth of the ceiling. It is indispensable for the silkworm rearing house to have also the preparation for ventilation of the roof.

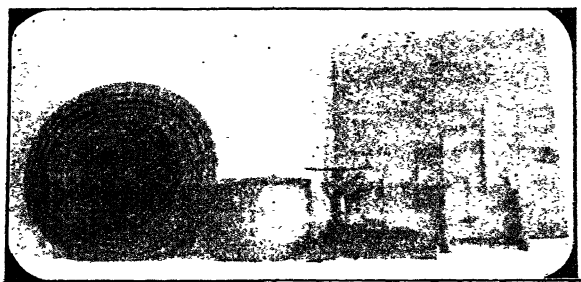
There are several kinds of roofs, such as, tile, shingle and thatched roofs. Among which the last is the best suited for the nursery, so as to slowly conduct the outside heat and the tile roof is next. The shingle one is not suitable for a silkworm rearing house on account of the fact that if affords the least protecting from the influence of the outside temperature. Surrounding the nursery a gallery is made in order to regulate the sudden change of the outside temperature and to facilitate the actions of the rearers. The south and north sides of the gallery are from four and half feet to six feet in width, and the east and west over three feet as one pleases. In the middle of the nursery a hearth is prepared, which is made of fireproof

stones or bricks and covered so as not to hinder the working of the industry.

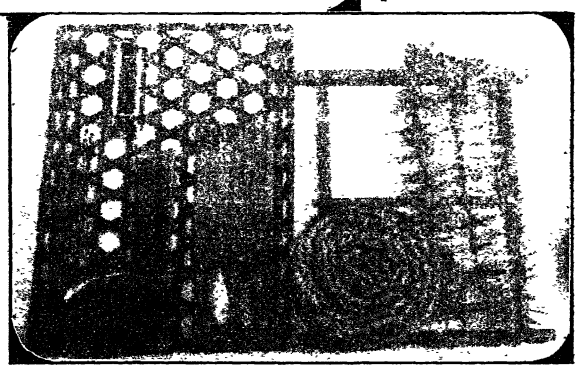
D. Instruments.

Whether the instruments for feeding the silkowrms are suitable or not has also an influence on the health of the silkworms and the facility of their treatments. Finally it concerns the economy of the enterpise.

Now the principal instruments will be explained in the following pages. The frame-work: On both sides of the nursery, it is made along the wall for the reception of the trays. Boards, 1 inch by 8 inches serve as the uprights, the tops touching the ceiling. Light bars of bamboo to support the trays should be suspended across the uprights horizontally with a proper space, about ten inches, between every two bars. The closer distance is not good for ventilation and becomes unhealthy for the silkworms.



IMPLEMENTS FOR PREPARING SILKWORM FOOD.



REARING IMPLEMENTS.

The silkworms trays: These are made of split bamboo; there are two forms, the circular and rectangular, with various sizes, but those popularly used and found to be convenient for practical purposes, are the rectangular 3.5 feet by 2.5 feet with a level border. The circular ones, 2.5 feet in diameter, are also widely used. The circular tray is made very easily, but in actual use, the rearers may have much trouble to cut the mattings and nets, so as to fit to it, their being generally rectangular, and moreover their borders cut, should be repaired. Still their handling is troublesome and they become worn out and wasted in a short time. Another kind of trays is the one connected with a matting which is lined, but it is very inconvenient in handling.

Mats: These are better made as light as possible but not so light that husks (which are often scattered on them) and silkworms' excrements may leak down. The *Itodade* mats (the other name the *Minagawa* mats) woven of cotton or hemp thread as the warp and of straw as the woof, are conceded to be suitable for the practical use.

Nettings: Those which are used until the fourth age, are made of cotton threads. There are different kinds of nettings with various sizes of meshes, 0.1 inch, 0.15 inches, 0.2 inches, 0.3 inches, and 0.5 inches. These nettings serve chiefly for the removing of the litter and the taking out of the late moulting worms after ceasing to give them the mulberry leaves. The nettings used during the fifth age are made of straw ropes, hemp or Juncus communis and are chiefly used for the removing of the litter. The most suitable size of the meshes in some 2 inches. Besides the instruments described above, basins, the

knives for cutting the mulberry leaves, the sickles for cutting the mulberry branches, sieves, winnows, the tray holders and feather brushes are wanted. As the instruments for *mounting*, *Ebiragomo* (the special matting for spinning cocoons) and *Mabushi* (the straw cocoonage) are necessary. There are several kinds of the cocoonage among which *Oriwara* and *Mukade-mabushi* are practically used. The former is a cradle made of straws folded and the latter consists of one or two ropes, with straws inserted cut 6 inches in length, with the shape of a caterpillar with long and thick hairs. The important instrument for graining is a moth frame which is a ring, with a funnel shape, made of thin zinc plate. The suitable size of the large opening is from some 1.8 inches to 2 inches in diameter, the small one 1.8 inches and its length some 0.5 inches to 1 inch. There are two kinds of moth frames, namely, the individual and the connected which consists of 28 rings (these are for one egg-card). Another convenient frame is a board, about one inch thick, of the same size as the egg-card, with 28 holes, some 1.8 inches in diameter, which are lined with zinc plates.

III. The Silkworm Seed or Grain.

The silkworm eggs, laid on a card is sometimes called *seed*. Whether seed is good or not, has a close relation to the crops of cocoons. How expert the rearer may be, he can not raise abundant crops from unsound seed; so the egg-card manufacturers should endeavour to produce sound seed with the most skilful arts and the most profound attention. Or how excellent

the seed may be, the rearer can not get the most vigorous silkworms, if the seed should be improperly preserved and protected, so the rearer should take great care of the seed to keep it sound and free from disease.

A. Egg-card Making.

Egg-card manufacturers select cocoons for *reproductive* purposes after finishing the following examination on the original silkworms and the cocoons collected :—

(1.) The growth of the original worms.

The number of diseases during the period of feeding, is examined and if many of the silkworms are attacked by Flacherie, Pébrine, etc., their cocoons are not used for reproductive purposes.

(2.) The quantity of the cocoons collected.

If the quantity of the cocoons collected for one *momme** of "*ants*" is less than 5.5 kilograms, that is short crops, they are not utilized for the same purposes.

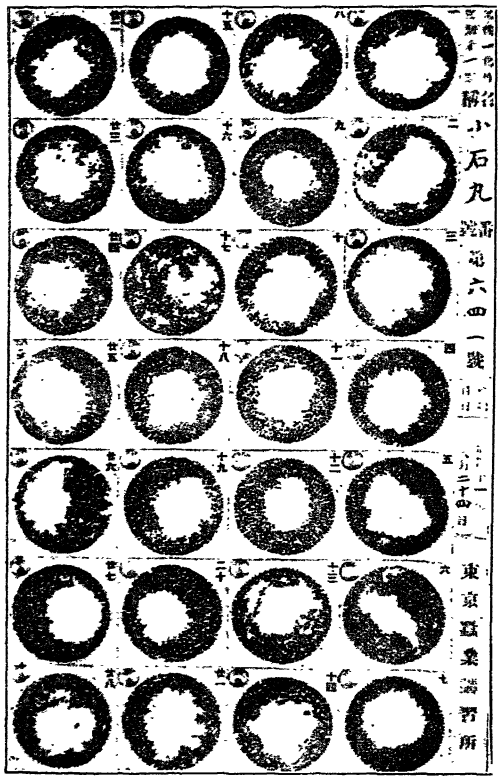
(3.) The examination of Pébrine.

If when the pupae are examined under the microscope, over 15 per cent. of them are found to be attacked by Pébrine, the cocoons are not employed for the preparation of seed.

After the above examinations, the size, color, luster and the roughness on the outside layer or granulation of the cocoons are next examined. Thus the cocoons which have the qualities peculiar to their variety, and a middle size, are selected for the

* *momme* = 3,75 grams.

raising of eggs. The cocoons thus selected, are arranged on trays, placed on the frame-work in the nursery which is ventilated and whose inner temperature is regulated always to keep at from 70 to 75 degrees F. just as in the feeding of the silkworms. Three weeks in the case of the annuals and 17 or 18 days in the case of the bivoltines or the polyvoltines passing, after pupation, the moths appear. The cocoons are covered with papers at night before the moths come forth. Newspapers may serve as the covers, which are perforated in the shape of the feather of an arrow to the amount of at least five or six in every square foot. The moths rest on top of the paper after passing through the apertures of the covers, soon after escaping from their silken prison. The cover facilitates the picking up of the moths and prevents the cocoons, left by the moths, from being stained with their excretions. If the temperature of the nursery is moderate, the exist of the moth is generally made in the morning between four and eight o'clock. The female moth appears soon after the male does. While they are pairing, the couples are kept quietly in a dark room, carefully shutting out the wind. If the room is bright or the wind blows in, an accidental uncoupling occurs. Pairing is allowed to continue for five or six hours. Between noon and one o'clock in the afternoon, the couple are separated Before the female moths are transferred to the egg-cards, they are allowed to excrete urine. For this purpose, some 60 or 70 moths are placed on a piece of paper which is shaken a little while by one end. Then after some five minutes more they are shaken again, for the purpose of causing them to urinate. After this operation, for *industrial reproduction*, the corresponding number



CELLULAR SYSTEM EGG-CARD

of the moths for one egg-card, is transferred to a card for the laying of its eggs, while, for *cellular reproduction*, each moth is individually placed in a frame. During the laying of the eggs, the proper temperature is between 75 and 89 degrees F. and the proper humidity is about 70 per cent. When the temperature is too low, the moth takes too long time to deposit its eggs and moreover produces less eggs. When it is too wet, the egg-cards are stained by scales from the wings and their attachment to the egg-surfaces. In the proper temperature, the moths commence to lay their eggs at 6 o'clock in the evening and finish the operation at about 10 o'clock at night. In the method of *industrial reproduction*, the moths are soon picked out and disposed of, while in the *cellular* plan the moths are carefully collected. The making of common egg-cards by *industrial reproduction* is the method in which about a hundred moths are allowed to

lay their eggs indiscriminately on a card, 1 foot 2 inches by 9.25 inches, while in *cellular reproduction*, a card of the same size with that of *industrial reproduction*, is divided into 28 divisions to which the number is given, and small frames are placed in every division, in each of which, one female moth is kept to lay eggs. After finishing their laying eggs, each of them is placed in the bag of the *cellular* which has the corresponding number, for their microscopical examination.

B. Precautions with the Seed.

Even if the seed be sound, yet if it has not been carefully protected, it becomes feeble, and in the worst cases, fails to hatch. The seed of the annual remains about ten months in this form, and during another two months, it is metamorphosed first into the larva, next the pupa and finally into the moth, which will lay eggs again. The eggs are exposed to various changes of temperature during these periods, namely, at the beginning they are kept very warm, then they are gradually allowed to become cold, and are again warmed up in the spring, when the egg hatches.

On account of the fact that the nucleus of the egg is constantly changing in the state of its growth, according to the change of temperature, the methods of precaution should be varied in accordance with this fact. Generally, the period of the necessary precaution is divided into four, according to the growth of the nucleus. Now the methods for the exercise of precaution in every period will be explained in the following pages:—

(1.) Precautions during the first period.

The first period is one week after the eggs have been laid, namely, the period during which, the light yellow eggs turn gradually to a drab grayish color, proper to the egg. The eggs change not only their outer aspects during this period, but their interiors also undergo a remarkable change. They are placed on the trays, which are sometimes put into frame-work after supplying them with enough fresh air owing to their strong respiration, and the temperature in the room is kept between 70 and 80 degrees F., thus avoiding away sudden change.

(2.) Precautions during the second period.

The second period extends over from the end of the first period to the close of December. On account of the fact that although at the beginning of the period, it is still warm, the respiration of the eggs becomes gradually weak and their unclei fall into a dormant state in the autumn; the precautions taken during this period are the simplest amongst all.

The egg-cards are put into a frame-work or hung down by means of threads in a room clear and well ventilated. At the end of this period, the excretions of the moths, the scales on their wings, and any other dirt, attached to the eggs, which may often injure the larva in hatching, are washed off. For this purpose, several vessels of fresh water are allowed to remain for a while to permit the water to attain the same temperature as the air; then, the eggs are dipped into the water. After some four or five hours, they are taken out of the water one by one, and placed on a board, which has been prepared beforehand, in order to that they may be brushed softly and washed carefully.

After this operation, fresh water is poured on them, and they are transferred to a clean room, putting on the trays, where they are dried in air and then kept in conservation.

(3.) Precautions taken during the third period.

By this we mean the precautions necessary between the close of December and the period of the mulberries' budding. At the beginning of the winter, the eggs become dormant and breathe so feebly that the eggs, laid by a hundred moths (they weigh some 30 grams at the time when laid), are not injured for want of oxygen even in a sealed vessel, if only one litre of air is given to them during this period. The eggs in the dormant state are capable of beginning their growth at any time when they are kept at a temperature of over 50 degrees F., but they are so injured by their growth being stimulated out of the regular time, that the sound seed may often become weak and in the worst cases it may become of no use. Hence the precautions taken during this period are nothing but that the eggs in the dormant state are kept in stillness so as not to be exposed to any sudden warmth. The limit of the temperature in every month during this period is shown in the following list:—

The temperatures in the conservation of the eggs during the third period.

December	under	40	degrees	Fahrenheit
January	„	35	„	„
February	„	40	„	„
March	„	45	„	„
April	„	50	„	„

The keeping of the eggs at a constant temperature, notwithstanding the change of the external temperature, is carried out by one of the following methods:—

The first mothod: A double case is made for conservation. The space between the outer and the inner case is at least over 6 inches, which is filled up with non-conductor of heat, such as saw-dust, etc. The case may serve to conserve 200 egg-cards.

The second method: A store house is built for conservation, which consists of two buildings one over the another. The walls of both buildings are made thick to prevent them from being affected by the external heat.

The third method: The eggs are conserved in a cave or *Fūketsu*, or in a store house specially prepared for cooling, among which the latter is very convenient for storing on account of the operators being able to regulate the inner temperature as he wishes.

(4.) Precautions during the fourth period.

This is the precaution taken between the end of the third period and the hatching of the eggs. This period is about two weeks, and is often called the period of *incubation*. The purpose of the precaution in this period is to make the nucleus of the egg grow up regularly by a steady rising of the temperature.

The standard temperatures during the period of *incubation*. are as follows:—

Day.	Standard temperature.	Day.	Standard temperature.
1st day	55 degrees F.	8th day	62 degrees F.
2nd „	56 „	9th „	64 „
3rd „	57 „	10th „	66 „
4th „	58 „	11th „	68 „
5th „	59 „	12th „	70 „
6th „	60 „	13th „	72 „
7th „	61 „	14th „	72 „

By the rising of the temperature as shown in the above table, the color of the eggs turns to a grayish white by the eleventh day, a few of them will hatch by the thirteenth day and a great many of them by the fourteenth day. The precaution taken during this period is to raise the temperature regularly, without making any mistake, to let a sufficient quantity of fresh air into the room for the respiration of the eggs and at the same time to keep the air sufficiently humid so as not to dry them too much.

IV. Rearing of the Silkworm.

The time for *incubation* determines the time of "*brushing*"; and the time of *brushing* has very much to do with the crop of mulberry leaves and the quality of cocoons produced. In case *brushing* be carried on too early, the growth of the silkworms will be rapid, and the quality of the cocoons spun by such silkworms will prove excellent, while the crop of mulberry leaves will be considerably affected. If, on the contrary, *brushing* be undertaken too late, though we might expect a larger crop of mulberry leaves, they will lose some of their nutriment, and become too corase as food for the young silkworms, spoiling the growth of the worms and the quality of the cocoons. Moreover, maggots are more apt to injure such late hatched silkworms, and high atmospheric temperature and humidity would give much trouble to the latter ages of their silkworms. So strict care must be taken to determine the proper time for *incubation* in consideration of the budding of mulberry leaves. It usually done and satisfactory in result to take out the egg-cards

from the preservation room at the budding of the first leaf of the early-budding variety, and keep it in the standard temperature mentioned before. This date of budding varies somewhat according to the place and year. In Tōkyō and its vicinities, in the experience of more than ten years, the earliest date was April 11th., and the latest April 23rd., the average date being 16th., or 17th., of April, which will, therefore, be the best time to commence the process of *incubation* in a usual year, but in case the budding takes place very much later, *incubation* must be commenced one or two days before the day of budding, and if the reverse is the case, *incubation* should be undertaken one or two days after the day of budding. This is so done, because in such a year that budding takes place too early, we may inevitably expect abnormally cold weather after the budding to retard the due development of mulberry leaves, while in the year of late-budding, a sudden warmth after the budding will cause the rapid growth of the mulberry foliage.

A. Brushing.

By *brushing* is meant the reception of newly-hatched silkworms into a feeding tray from the egg-card by *brushing* them off. Delicate treatment is required in *brushing* off the young silkworms, as they are extremely small and weak in body, and may be lost or wounded through the slightest carelessness. Various methods of *brushing* have been advocated, but the one most widely practiced at present is the *Uchiotoshi* method, a brief explanation of which is given below.

Some silkworms hatch out usually one day after silkworm eggs have assumed a whitish gray color. These early hatched worms are called *Hashiri* (forerunners), and they must be brushed off and discarded, as they are not likely to spin good cocoons. The egg-card, after these early hatched silkworms have been brushed off, is wrapped up in a broad sheet of *Mino* paper, so that the young worms may not crawl off the card and be lost, and in this state it must be kept until the next morning, when under proper temperature and humidity the young silkworms begin to hatch out at five or six o'clock and the hatching for the day goes on until about ten o'clock in the morning. In ordinary cases, some 70 per cent. of the eggs on the card hatch out in one morning, but in some rare cases, the percentage may fall below 50. In such cases, the egg-card must be covered up again and kept untouched in a room with a temperature of 70 degrees F. until the following morning, when the process of *brushing* is to be taken up anew. This method must not be resorted to, when the natural atmospheric temperature is above 72 degrees F., as it may tire out the worms in the act of hatching.

Brushing should be carried out at about eleven o'clock in the morning. In the first place the egg-card is taken out of the wrapper and the young silkworms that may have crawled over to the back of the card are gently brushed off by means of a feather-broom. Then the card is turned over and held up tight with the egg-side downward, some five inches above a sheet of paper weighed beforehand, and a few succeeding taps are given the card on its back with the feaher-broom or any other thing near at hand. Most of the worms are removed from the card in

this way, but the rest still clinging to the card have to be brushed off on the paper with a feather-broom, and then all the worms received are weighed together with the paper, and thus the net weight of the newly hatched silkworms is determined by reducing the weight of the paper.

Silkworms immediately after hatching are called *ants* and the weight of such young silkworms is technically termed "*ant weight*." As *ant weight* is very essential in determining the approximate number of silkworms, and a slight error in *ant weight* might bring an utter failure in all later plans, an accurate balance and strict care must be used in weighing such *ants*. As a rule, allowing 90 per cent. for hatching, the eggs laid by 100 moths will gain an *ant weight* of between $4\frac{1}{2}$ and 5 *momme*, and one *momme* of *ants* usually contains from 9,500 to 10,000 *ants*.

After the weighing has been finished, millet or rice husk is sprinkled over the paper just to cover the *ants*, and mulberry leaves chopped fine are also scattered over just to equal the quantity of the *ants*. These mulberry leaves are not meant for food, but merely for the purpose of inviting the *ants* to come out over the husk. Some thirty minutes later when all the *ants* have crawled out of the husk, a fresh supply of husk is again scattered over them, and the *ants* and husk are then evenly mixed up by gently jumbling them with the feather-broom and the fingers. The usual quantity of husk required for this purpose is 2 *gō** per one *momme* of *ants*. After this, the *ants* and husk together are taken over into a bowl with a paper sheeting, over which they are to be scattered with proper

* 1 *gō* = $\frac{1}{3}$ pint.

evenness, giving one square foot for one *momme* of *ants*. Some twenty minutes after this, almost all the *ants* come crawling out over the surface, upon which the mulberry leaves are then given as food for the first time. Here begins the most important yet intricate process of feeding, which shall be treated of under the next heading.

B. Feeding.

The growth of the silkworm varies a great deal according to the difference of temperature and humidity. Necessary variations must be given also to the methods of feeding, to the litter-clearing, and to the extention of the silkworm-bed in consideration of the temperature and humidity, under which the rearing is undertaken. Taking 70 degrees F. of temperature from and from 75 to 80 per cent. of humidity for our example, we shall describe here the methods required in the proper rearing of silkworms.

Young silkworms are observed to take food at more frequent intervals than the old ones, and the soft mulberry leaves required for the young worms dry up more readily than the coarser leaves that are fit for the older worms; therefore it is advisable to feed the younger silkworms with a smaller quantity of food at more frequent intervals, and according as the age of the silkworms advances, to increase the quantity of mulberry leaves for each feeding and decrease the number of feedings in a single day. Supposing that the temperature and humidity of the rearing room are as those before mentioned, the appropriate number of feedings in one day in each age of the silkworm is as follows:—

	No. of feedings in one day.
1st age	...From 7 to 8 times
2nd „	„ 6 „ 7 „
3rd „	„ 5 „ 8 „
4th „	„ „ „ „ „
5th „	„ 4 „ 5 „

Some feed their silkworms less frequently in one day than is shown in the above table, for the mere purpose of saving the labour of feeding; it is, however, a bad practice, when the health of silkworms is taken into account, for, if too much food is given in one time, as is naturally the case, the silkworms may be led to take such leaves as are fouled by their own excrements, which would affect their health unfavorably and induce some contagious diseases. This is also unprofitable from an economical point of view, as many leaves may be left unconsumed. The quantity of the leaves to be given in one time, must be modified in accordance with the temperature, humidity and appetite of the silkworms. Generally speaking, in warm and dry weather, silkworms show evidences of a stronger appetite, so that they must be given more food, while on a wet and cold day, they seem dull and want but little food.

During two or three days after every moulting, the appetite of the silkworms decreases, so that the quantity of food must also be decreased, but as the time for the next moulting approaches, silkworms gradually regain their usual appetite, and they must be fed accordingly. After all, the serect of feeding is to make the silkworm eat as much as it pleases, and leave as little leaf as possible unconsumed. If much food is left unconsumed in the tray, it is not only uneconomical, but makes an

accumulation of litter, which is very objectionable for the health of silkworms. So in feeding silkworms, a delicate and sympathetic discretion must be exercised as to the quantity of food and the appetite of the silkworms as well as to the cleanliness of the tray. The quality of the mulberry leaf varies according to the variety and state of its development: some are coarse, and others soft; the younger leaves are invariably softer than the older ones. As the digestive power of the silkworm varies also according to its age, care must be taken in feeding silkworms with such leaves as are in the proper state of development. If young silkworms are fed with coarse leaves, they are likely to attain an irregular growth, and if very coarse leaves are given, they may fall victims to some kind of disease. If on the contrary, older silkworms are given only soft leaves, they may grow very fat, but become also subject to diseases.

The thickness of the mulberry leaf varies somewhat according to the variety; and the thick leaf is not suitable for young silkworms. So the early-budding variety that is used for young worms should be selected from among those varieties whose leaves are thin, and the late-budding variety with thicker leaves should be cultivated for the use of the older worms. The quantity of moisture contained ni the mulberry leaf has very much to do with the health of the silkworm. If silkworms are fed with leaves with too much moisture, they may grow fat but become more subject to diseases, while the leaves with scanty moisture will cause the imperfect growth of the worms and good cocoons can not be expected to be produced by such silkworms. The appropriate degree of moisture can be attained when 100 *monme* of live leaves has been reduced to 95 or 90 *monme*.

For so doing ample care is required in the preservation of the mulberry leaves, and the temperature of the rearing room must always be properly regulated. In addition to these requirements, the regular distribution of mulberry leaves in the tray must be carefully observed.

As young silkworms seldom move about very far, the uneven distribution of mulberry leaves in the tray may cause an uneven feeding, which naturally leads to the irregular development of those silkworms. As their age advances, silkworms become more active in motion; neverthless the uneven distribution of the mulberry leaves in every tray will cause some irregularities in their growth.

C. The Chopping of Mulberry Leaves.

Mulberry leaves are chopped so that they may be evenly distributed among the silkworms in the tray. Chopped mulberry leaves are used for the silkworms from the first age to the beginning of the fifth age. They must be cut square, their sizes corresponding to the age of the silkworm. Irregularly chopped leaves will be quite contrary to the object of chopping and end in the waste of labour.

D. The Preservation of Mulberry Leaves.

As previously mentioned, mulberry leaves wet with rain drops or with much moisture are liable to cause silkworm diseases. So prudent silkworm rearers will do well to keep some surplus mulberry leaves in store to prepare against rainy weather or to give chances for evaporation of the moisture in

the leaves. But a misguided method of preservation will often result in the withering or the fermentation of the leaves, making them quite worthless for practical purposes. There are two methods for the preservation of mulberry leaves; one is suited for the preservation of plucked-leaves, the other for leaves left on their twigs and branches. Plucked-leaves, are convenient for preservation, taking up a much smaller space, but they often become fermented, while in the case of leaves left on their twigs, though they are free from that danger, yet they have the defect of requiring a larger space. Mulberry leaves for young worms, wither fast, but as they are usually plucked from the branches, their volume is small, and if kept in a pail or an earthen pot in such a way as to prevent hard pressing, they may be preserved more than 24 hours without any injury. The silkworms in the fifth age consume a greater quantity of mulberry leaves, and their preservation requires more bulky equipments of the storage. The mulberry preservation room, must be kept at comparatively a low temperature, with but little light and ventilation. An underground room will make an ideal place of storage. Branch with their leaves left on kept vertical in loosend bundles can be preserved for two or three days without injury. Plucked leaves must be preserved in baskets (3½ft. long, 2½ft. wide, and 8 in. deep) and put on racks in the preservation room. Sometimes, roughly woven bamboo mattings are used, on which some five *kwan* of plucked-leaves are set in regular lines and rolled up and tied in two places. If this roll is kept in an underground room in a vertical position, the leaves may be safely preserved for two or three days.

E. The Extention of the "Silkworm-Bed."

In some five weeks that cover the period from the hatching of the silkworm to its maturity, the silkworm rapidly increases in its weight to the extent of about 10,000 times. Its growth is especially remarkable in the first age, at the end of which it attains the weight some 15 times its weight at the time of hatching. After from the second to the fifth age, the increase is from $4\frac{1}{2}$ to over 5 times in each age. As the growth of the silkworm is thus wonderfully rapid, the dimensions of a bed allotted for each silkworm must also be widened, according as its age advances.

Different rearers follow different methods in extending the dimensions of the silkworm-bed, but here again moderation has much to do with the health of the silkworm and the economical interests of silkworm rearing. The narrow bed may somewhat save in the use of mulberry leaves and in the labour of feeding, but silkworms thus situated are apt to attain an abnormal development and, in consequence, a good crop can hardly be expected, while in case too wide a space be allowed for the silkworm-bed, though it may be very encouraging for the health of the silkworm, the labour of feeding and mulberry leaves will be wasted to some extent, so that this is also defective from an economical point of view. On the whole, narrow beds are preferable to wide ones for the younger silkworms, whereas in the case of the older worms the reverse is the case.

The dimensions of the silkworm-bed fit for the silkworm in each age is shown in the table below :—

	From the first to the middle day.	From the middle day and later.
	sq. ft.	sq ft.
1st age...	1- 3	5
2nd „	3- 9	12
3rd „	12-18	30
4th „	18-30	60
5th „	60-90	90

N. B. The table shows the dimensions required for the silkworms of one *momme* of original *ant weight*.

The process of extending the silkworm-bed is generally carried about just before the silkworm attains its full-growth in each age. In the first age, it is performed three times, in the first day, in the third day, and in the fifth day, after the hatching respectively. From the second up to the fourth age, it is convenient to perform this twice, each at the time of the first and the second litter-clearing, while in the fifth age, it is usually done once together with the first litter-clearing.

F. Litter-clearing.

The excrements of silkworms and the unconsumed mulberry leaves remaining in the tray are inclusively called *litter*. The accumulation of litter in a feeding tray should be strictly guarded against, as it is bound to give excessive moisture to the tray, and render the silkworms subject to various diseases. So it is absolutely necessary to keep the trays always clear of litter, but if the humidity of the rearing room be properly regulated and the methods of feeding be justly followed, litter-clearing will be sufficient, say, once or twice in each age from the second

to the fourth age of the silkworm. In the fifth age, however, the excretions of the silkworms become very lively, and the rainy weather makes the rearing rooms all the more damp, so that the litter should be cleared off once or twice every day. In the first age, silkworms are so small in size that they may be lost in the very act of litter-clearing; therefore, it is advisable to postpone this process until the time of moulting, unless an excessive amount of moisture is observed in the feeding tray.

The litter-clearing from the second up to the fourth age, is practiced three times in each age; the first clearing is to be performed when the silkworms have been fed three or four times after moulting; the second clearing is in the middle of each age, and the third clearing is just before moulting, when the silkworms show a dull appetite. The litter is usually cleared off by means of nettings, but it is as commonly done by sprinkling rice husk in the tray, upon which the silkworms crawl out, and then are carried over to other trays by means of a feather broom. The former method is applied to the silkworms in the fifth age, while the latter method is followed between the second and the fourth age.

G. The Protection of Silkworms after Moulting.

When silkworms have attained a certain state of development, they drop their appetite entirely and have a rest for some time. Silkworms in this state are said to be "*sleeping*." A new skin develops in the course of *sleeping*, and they awake casting off their old skins. This process is called *moulting*. The skins of the silkworms that have moulted are delicate and extremely sensitive to trivial changes of temperature and

humidity, so that special care is necessary for the protection of such worms. As *sleeping* silkworms are fond of airly and dry spots, they should be given a place as clean and dry as possible, and special care is required to prevent them from being left buried under the litter. In case some silkworms do not go to sleep even if fed four or five times after the last litter-clearing has been performed in that age, they must be transferred by means of netting into another tray to be fed therein, lest other silkworms that are *sleeping* should be covered up by the litter. During this period, the rearing room must be kept from any noise, and it is also desirable to keep the temperature one or two degrees lower than usual in the room. When any silkworms have finished moulting, draught and excessive light should be carefully kept from them, as those silkworms would crawl off from them and be crowded to one side. It is customary and better to resume feeding after all the silkworms have finished moulting. Should the silkworms that have moulted be observed as restless owing to an abnormal rising of the temperature, or a sudden attack of storm, they had better be given food, even though there be some one per cent. of the silkworms, still *sleeping* in the tray. Under ordinary conditions of weather and proper methods of protection, those silkworms that have finished moulting do not like moving about, and keep their beds for about 30 hours after moulting. But in case of a high temperature or a stormy day, or should they be affected by any bodily disorder, they will keep moving about in the tray incessantly. In such a case as this, if food is not given them, they may be compelled to succumb to some harm or other. In an ordinary case, twelve hours after moulting is considered the best time to

resume feeding. Mulberry leaves to be given to moulted worms should be of a somewhat softer quality, as their digestion has not yet regained its original activity. The quantity for one meal must also be moderated by one or two per cent., and some gradual increase should be made later.

H. The Temperature and Humidity of the Rearing Room.

The growth of the silkworm is very much affected by the difference of the temperature in the rearing room, and the method of rearing must be considerably modified by the humidity. So that temperature and humidity play an important part in the physical development and economical rearing of silkworms. We shall give here a resumé of the different number of days required from the hatching of silkworm eggs to the spinning of the cocoons in the different temperatures.

Average temperature.	No. of days required.
65 degrees F.	Some 40
70 „	„ 35
75 „	„ 30
80 „	„ 24

As is shown above, the number of days required for the rearing of silkworms in one generation varies according to the different temperatures of the rearing room; nevertheless, if properly reared and protected, they may attain due development and spin cocoons in any case. We may, however, infer from this table a certain moderate degree of temperature, in which silkworms can be reared with the most satisfactory results.

Silkworms usually grow up properly and can be reared with little trouble in a temperature of between 65° F. and 75° F. In a lower temperature, their growth is slow and ununiform, while in a higher temperature, though their growth may be quick, they are more subject to various diseases. Silkworm rearers have, therefore, to be very careful in keeping the rearing rooms at the proper degree of temperature. In the first stage of the spring yield of silkworms, usually a low atmopheric temperature prevails, while in the summer and autumn yields, the temperature is mostly high. In the former case, such rooms are recommendable as are convenient to retain heat supplied by some heating apparatus. In the latter case, cool rooms should be selected, so that the effect of excessive light and heat may be averted and cool air may be let in to prevent the sudden rising of the temperature. In case the atmospheric temperature rises to 90° F., no matter whatever protection may be given, silkworms lose their appetite considerably, and in consequence, they spin cocoons of an inferior quality.

The influence of humidity on the growth of silkworms is not so remarkable as that of temperature; nevertheless, it affects a great deal the hatching of silkworms and the quantity of mulberry leaves consumed. If the air in the rearing room be too dry, mulberry leaves will dry up quickly and become wasted, and at the same time, the scanty moisture in the leaf will render the silkworms that should eat such leaves subject to incomplete development as well as to diseases, while, on the other hand, in case the air in the rearing room contains too much moisture, the mulberry leaves may not wither up so readily, and the waste may be smaller

accordingly, but sit is quite as probable that the litter and silkworm-beds may become moistened, inducing the fall of the appetite of silkworms, and the steady development of micro-organisms, to which many silkworms would fall victims with wondrous rapidity. In fact, the moderation of the humidity, together with that of the temperature, is an indispensable condition in the rearing of silkworms. The humidity fitted for this purpose lies between 70° F. and 80° F. Should the air in the rearing room be observed over-dried, sprinkle water on the floor or sweep the floor with a wet cloth, or in case any fire be found in the room, get a kettle on it so that the water in the kettle may be evaporated and make the air in the room contain more moisture. If, on the contrary, the air should be observed to be saturated with moisture, throw open the windows and any other openings, and contrive to dry the room by means of fire-heating. In case the temperature of the room be so high that fire should not be used, parched rice husk, or lime must be sprinkled over the tray so as to hasten the drying of the litter. Some two *momme* of lime will be effective if it is sprinkled over a square foot of the feeding tray.

I. Application of Fire.

Fire is used in the rearing room for heating and drying purposes, as already referred to. There is another way of applying fire used with equal frequency and substantial benefit. In case there is no breeze in the air and the room is close and stifling, a fire is often made for causing the circulation of air-currents in the room. This great benefit of fire may, however, turn out as great a cause of destruction through its misguided

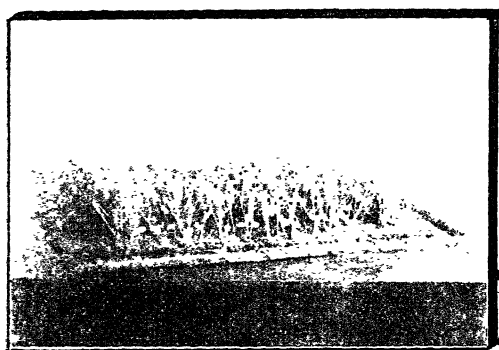
application. If the rearing room is not properly equipped for free ventilation, the room will naturally become filled with carbonic acid gas produced by the combustion of charcoal in the room, which will do great harm to the silkworms. The repeated failures of those who use fire in the rearing room lie in this point. Such men are strongly adviced not to neglect to open the windows and doors as that the carbonic acid gas may escape and fresh air may come in through so as to keep the circulation of air-currents always active in the rearing room. In case fire is used as a mere contrivance of ventilation, not only should the windows be wide open, but the paper-shutters round the room should also be kept open for a proper duration of time.

J. The Mounting of the Silkworm.

When the silkworm has attained its full-growth in the fifth age, its appetite fails all of a sudden and its body assumes an amber color and it throws out a fine thread from its mouth, restlessly moving about in search of a place fit for spinning a cocoon. A silkworm in this state is called *matured*. The process of transferring these matured silkworms into another tray fitted out for this special purpose is termed "*mounting*." The most important thing that requires special attention in this process is the determination of the proper state of maturity of the silkworm. Over-matured silkworms must needs have lost a great deal of its thread before *mounting*, which is in itself not a slight loss, and moreover, its body becomes shrivelled up and loses the activity of motion. Such a worm is most likely to spin a deformed cocoon, or a double cocoon. If, on the other

hand, those silkworms that have not yet fully matured, do not commence spinning at once, but crawl about the tray, spoiling other cocoons with their excrements. Such silkworms, as an inevitable result of their unfinished feeding, spin out a smaller quantity of silk, and so are of less value for reeling purposes, and are not either fit for reproductive purpose because of their imperfect growth.

Silkworms are said to be properly matured, when the first nine or ten segments of their bodies have become transparent and the last two or three segments remain not yet transparent. Rearers must not lose a moment to pick up such silkworms that have attained this state of development.



FOLDED STRAW COCOONAGE.

CENTIPEDE COCOONAGE.

The number of silkworms to be mounted in a certain area of the "*cocoonage*" varies according to both the kind and the construction of the *cocoonage*. In the case of the "*folded straw cocoonage*," fifty worms may be taken in a square foot,

while in the case of the "*centipede cocoonage*," the minimum is sixty. Silkworms packed in too densely are apt to spin deformed cocoons, stained cocoons, or double cocoons, spoiling the profit of the cocoon crop very much.

K. Protection of Silkworms after Mounting.

In a proper temperature silkworms finish spinning their cocoons in 48 hours after *mounting*, and in another 48 hours undergo the last moult and become pupae. The quality of the cocoon depends to a great extent on the protection given during this process. The defect in the luster and the reeling off of the cocoon is chiefly due to an imperfect protection in this stage. The items of protection required during the spinning of the cocoon are mainly as follows:—

(1) The temperature of the room must be kept between 75° and 80° F.

(2) The air in the room must be kept as dry as possible under 70° of humidity.

(3) The room must be well ventilated.

(4) The sun-rays must be evenly let into the room, and excessive rays should be kept off.

Should the temperature of the room fall below 70° F. in the course of the spinning, the silkworms often suspend their work until some higher degree of temperature is attained. In such cases, the layer of the cocoon-wall is likely to become doubled with an intervention between. If such suspension takes place twice, a threefold layer will be the result. Cocoons of such construction cannot usually be reeled off completely, but only

the outer layer is available. So any excessively low temperature of the room should be raised to a desirable degree by fire-heating. If, however, the temparature of the room be higher than 80° F. at the time of *mounting*, silkworms commence spinning at any random places without taking the trouble to find proper spots, and in most cases are apt to spin double cocoons, which cannot be used for the material of superior silk fabrics. Cocoons spun in a room with excessive moisture do not dry quickly and their filaments stick together too much, so that much difficulty is felt in reeling such cocoons, and this is especially the case with such cocoons that are spun in a high temperature in addition to a strong humidity. Prudent care should therefore be taken in having the room kept dry while the spinning is going on. In case the air in the room be of a high humidity, though moderate in temperature, the room must be dried by fire.

As spinning rooms are filled up with *cocoonages*, they are liable to become ill-ventilated and spoil the health of the silkworms. Bad ventilation usually prevents the proper drying of the room, so that all windows and doors have to be duly opened so as to have the room well kept under proper humidity and ventilation.

If excessively strong sun-rays should shine upon a certain side of a cocoon, the worm inside is apt to make the wall of the cocoon thicker specially on that side, thus forming a cocoon of uneven thickness in its wall. So in the course of spinning care must be taken to make the sunshine evenly over a cocoon.

As previouly mentioned, silkworms finish spinning cocoons

in some 48 hours, so the regulation of humidity is important mostly during the first 48 hours after *mounting*.

After this, the room must be left open so as to induce the drying of the *cocoonages* by leading in fresh currents of air.

L. The Gathering of the Cocoons.

Generally silkworms turn out pupae inside the cocoons within four days after *mounting*, but at the time of this transformation their bodies are very soft and assume a light yellowish tint. In this stage any rude treatment will readily hurt their bodies and spoil the layers of the cocoons with the blood that has been pushed out. Two days later, their bodies turn a deep brown and become hardened, and less subject to any harm from outside. This is, therefore, the best time for gathering cocoons.

Cocoons gathered are generally sorted into the following classes :—

(1) Cocoons of a superior quality, that have the proper shape with a thick wall, fit for the material of the best raw silk.

(2) Cocoons of a medium quality, that are deformed, stained with dead silkworms inside, with a wall of uneven, thickness, or that are of imperfect construction.

(3) Cocoons of an inferior quality, that have very thin walls.

(4) Double cocoons, that have been spun by two or more silkworms.

Cocoons destined for reeling must be dried immediately after they have thus been sorted, while those intended for reproductive purposes have to pass an examination stated in a

preceding chapter, after which another strict selection must be made before they can be kept in preservation for their intended purpose.

V. Diseases of Silkworms.

Several diseases are found at present in our country during the breeding of silkworms. Among them those which cause great damage to sericulturists are Pébrine, Grasserie, Muscardine, Flacherie and the *Uji* disease. The damage sustained by our sericulturists due only to the latter is estimated at 15,000,000 *yen* every year, while that caused by the others is at least more than several ten millions of *yen*. It is not only in recent years that these diseases have been prevalent, but they seem to have been found from the most ancient times. One of them, described at the earliest time in our country is Muscardine just as it also prevailed in Europe. This disease was already described about a thousand years ago, then came Pébrine and Flacherie in 1712, Grasserie in 1817 and the *Uji* disease in 1814. But in the former times none of the proper ties of these diseases were thoroughly investigated. At the period, when sericulture was not so highly practiced as it is in these days, few of these silkworm diseases were prevalent and if they were so, the damage due to the diseases seems to have been insignificant. On the contrary, at present the sericulture of our country having been so much enlarged that it has penetrated and prevailed in every district and so much improved that silkworms are reared twice or thrice a year, the diseases have also grown to such an extent that they have ever threatend to destroy our sericulture. But

happily, they have been prevented according to the methods discovered by L. Pasteur and other authorities. Thus our sericulture has achieved to be such success as a safe enterprise which will not fall into any risk on account of those diseases.

Now we will describe briefly these various diseases in the following pages.

1. Pébrine.

Pébrine is a disease caused by the parasitic growth of a small ovoid organism, which is found to be Nosema bombycis Naegeli, a species of Sporozoa. The eggs of the diseased moth carry the germs of the disease and the worms which result from them are stricken down with it and it infects any healthy worms which come in contact with the germs which adhere to instruments or to the walls of the breeding chambers. The germ in the body of the silkworm develops into Amaeba which is distributed into every part of the body through the walls of the alimentary canal and grows up absorbing nutrient from the sick silkworm. Thus the micro-organism propagates by the direct division. After a while the primitive sphere appears in its interior in which spores are produced and finally it changes into a syst state. The spore is 3μ in length and 2μ in width, transparent and luminous. The ovoid micro-organism is found in quantities on every part of the worms, but especially in great many in the cells of the mucous membrane of the alimentary canal, the fatty tissues, the muscles, the cutaneous tissues, silk glands and reproductive organ and the cell attacked by the organism, being swallen and finally destroyed, we can clearly distinguish the injured parts in such simple tissues as

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the muscles and silk glands. On account of the fact that the propagation of the Nosema bombycis is generally slow, although there are exception sometimes, the diseased silkworm is not caused a sudden death but it gradually presents the symptoms of decay. The silkworm may be attacked with Pébrine in all periods of its existence, when the worm is young or mature, or while it is moulting, or also after it becomes a moth. The worm attacked with Pébrine presents the following symptoms. The color of the diseased worms turns a grayish white and they appear to be rather shiny in their moulting and finally they are not capable of moulting or even if the worms can moult, they eat but little and remain small and fade in color. Even in their growing periods they remain small being retarded in their growth. One can discern a few black spots in their skin, but the spots are not so many, as in the diseased worms of the European species: when the worms are attacked with Pébrine at their maturity, they are not capable of spinning cocoons, they gradually shrivel up and finally die; those which contract the disease in the pupal stage, often produce black spots in the part of their rudimental wings and legs; finally the moths attacked with the disease show a black color on their tails, their scales on that part falling down and black spots appearing on the wings. The worms thus attacked with Pébrine may often accomplish all the phases of their existence, but their growth is always retarded.

That the eggs of the diseased moths carry themselves the germ of the disease is due to the parasitic growth of the micro-organism in the reproductive organs. The spore is often parasitic to the egg cell and is often enveloped by the shell

while the egg is growing on, otherwise, it attaches itself to the surface of the egg. In both cases the spore causes the disease to attack the worm which results from the egg. Hence the selection of the eggs free from the spore under a microscope is of great importance to prevent the disease, and this is the fact which has been discovered by E. Cornalia and L. Pasteur some 50 years ago.

In order to prevent the disease from spreading the following means are practiced :—

(1) The careful examination of the seed.

Seed is raised by the cellular system and the moths are examided under a microscope. If we find the spore in them, the eggs which the infected moth has laid, are not used for breeding purpose, recognising them as being also infected. The other method by which one part of the eggs is examined under a microscope, being troublesome in actual practice, the former is preferable for all practical purposes.

(2) The washing of the seed.

In order to get off the spores that have attached themselves to the surface of the eggs, the egg-card is dipped into fresh water in winter and washed carefully, both before and after brushing the surface softly.

(3) The disinfection of instruments and breeding chambers.

In order to destroy the spores on instruments and in breeding chambers, they are disinfected. For the disinfection of breeding chambers, the formalin solution is sprinkled upon them and for that of instruments the solution is also used or sometimes steaming is recommended.

(4) Precautions during the breeding of silkworms.

The diseased worms are picked out as soon as possible, the litter is often removed to clean the bed; the inner temperature and moisture are so regulated as to avoid sudden changes and mulberry leaves are given to the worms in such proportions as to breed them vigorously.

2. Grasserie.

This disease is said to be caused by the parasitic growth of a kind of protozoa or some other organism. The cause which produces Grasserie is not well known at present time, however it has been known to be one kind of a contagious silkworm disease, because if the healthy worms are fed with mulberry leaves stained with the liquids that ooze from the diseased worm or they are injected with the liquid, they are always diseased. If we examine the liquid of the diseased worm closly under a microscope we find in any case an innumerable quantity of luminous corpuscles of a polyhedrous or spherical shape. The corpuscles peculiar to the disease are found not only in the blood but in the cells of various tissues in the silkworm body among which we find a great many of them in the fatty tissues and the tracheal membrane. The size of the polyhedrous golbules is variable, but the largest one is 5-6μ in diameter. Some recognize them to be the spores of the injurious organism but others attribute them to the accessory products of the same organism and do not regard them as being the very cause of the disease. The blood of the diseased worms, revealing the presence of an enormous quantity of polyhedrous globules, as we have described above, becomes milky. On this account,

the skin of the worm changes into a milky white, losing its proper color and presents an appearance approaching transparency. The body is distended as if it were suffering from a form of dropsy and its segments are especially swollen up. The skin, being feeble, the milky blood oozes through it out of the body of the insect.

The diseased worm does not moult at the proper period, its body swells up, its skin becomes gradually a grayish white and finally the worm dies changing into a milky white color. If worms are attacked with the disease a short time before maturity, they never ripen but swell up and die without spinning their cocoons. Even if they make a cocoon, they die in it before their pupation, sometimes a few of them may change into moths but very rarely.

For the prevention of the disease the following methods are applied :—

(1) The disinfection of breeding chambers and instruments.

On account of the fact that the liquid of the diseased worms disinfected with steam or the formalin solution, loses its contagious qualities, the disinfection of the breeding chambers and instruments is necessary as a preventive.

(2) Precautions during breeding.

The accidentally diseased worms should be taken out and the removal of the litter is of course necessary. Grasserie being caused by the bad breeding, the inner temperature and moisture are well regulated, the ventilation is kept well in hand, and the mulberry leaves are given at proper times and proportions.

3. Muscardine.

Muscardine is caused by the parasitic growth of a fungus called Botrytis bassiana Bals.. This injurious fungus propagates by the spore and often causes great damage to the feeding of silkworms. When the spore attaches itself the skin of worms, it begins to vegetate under the proper temperature and moisture, and gives out a filament called mycelium which develops through the skin into the interior of the body and absorbs its nutrients from the worm. The mycelium thus prolonged for a certain time and then branch, and produces an oval bulb called a conidium at its end. These conidia fall into the blood and develop for a little while to form secondary conidia. At this period all the tissues of the insect have been devoured by the formidable parasite and it can not escape from death. The time between the beginning of the parasitic life and the death of the diseased worm varies according to the age of the worm and the temperature during breeding, but as a rule young worms will die in shorter time than full grown ones and when the temperature is high, the diseased worm will die sooner than when it is low. The shortest of the periods is three days and the longest is two weeks. The conidia and the secondary conidia again give out mycelium which will branch soon after. By this time the dead worm takes on a petrified aspect and always bends a little. The dead body presents often a reddish violet color, owing to the propagation of the Bacillus prodigiosus Flügge in it. The myceliums which occupy the dead body produce special branches called conidiophores which exude from the skin and extend over the body fruitfully. After two days,

these conidiophores are so numerous that the body seems to be covered with white fleece. On the conidiophore the conical sterigma are produced on which spores are formed. When the spore is produced innumerably, the body presents an aspect as if covered with white powder. The spore is spherical and its size is 2μ to 3μ in diameter and buds on one side or sometimes two.

The worm stricken with this disease does not show any remarkable symptoms at the beginning and has every appearance of good health, but it begins to cease taking leaves, to be in agony and to show an intense impulse of its dorsal vessel a few hours before its death; moreover irregular brownish black spots often appear in the skin of the ventral or the lateral part of the body. In short it is always impossible to be aware of the presence of the disease until the first few worms have been suddenly stricken and die. The disease is specially characterized by the fact that the dead body becomes hardend after some days, and sometimes presents a reddish violet color which afterwards changes into white. Muscardine attacks not only the larvae but also both pupae and moths.

Beside Muscardine we find several kinds of silkworms disases caused by parasitic fungi. Those which have been known up to the present time are as follows: Nomuraea pracina Delacroix, Oospora destructor Delacroix, Isaria densa Link (A. Giard.), Isaria farinosa Fr., Isaria funosorosea Cashimir Wze., and a variety of Aspergillus species, etc. These injurious fungi cause sometimes great damage, but they are not so serious as in the case of the Muscardine.

In order to prevent the diseases caused by Botrytis bassiana and other fungi the following articles should be noticed :—

(1) The disinfection of breeding chamber and instruments.

By disinfecting the breeding chambers and instruments, the surviving spores of the injurious fungi which have devoloped in the previous breeding are destroyed.

(2) Precaution during breeding.

The worms attacked accidentally with the fungi are distinguished from healthy ones and are so far as possible taken out previous to their forming spores and the litter is often removed to clean the silkworms tray. Since a damp atomosphere greatly assists the growing of the fungus, we should avoid too much wetness in the breeding chambers so far as possible.

4. Flacherie.

Flacherie is a disease caused by parastic microbes. Although the silkworms in every stage are attacked by this disease, it especially happens at the end of the fifth age and the following days up to the time of moulting, causing serious damage to the sericulturists. Various bacteria are injurious to the silkworms among which Bacillus sotto Ishiwata, and Streptococcus bombycis Cohn. are important. The former is a bacillus with a rod like shape. The length is 2,6-6μ and the width is 1,5-2μ. The body is covered with a fruitful crop of fine cilia with which the bacillus moves violently. It forms an endospore in the middle or one side of the body. This endospore is oval and 1,6μ in the longer diameter. The bacillus produces a kind of toxin in this endospore and its pathogenic action is due to

the production of the toxin. So the bacillus which has been swallowed by a silkworm causes its sudden death after from thirty minutes to an hour. As we have described above the subjects attacked by the disease during suddenly in many cases, we can not perceive clearly the particular symptoms of the malady. The form and color of the body of an affected worm are not distinguished from those of a healthy worm, but in looking at the body carefully, we will find the following symptoms: The two or three segments near the head are somewhat transpearent at the beginning of the disease and the silkworm raises its head, shaking it right and left. The posterior part has always a wrinkled skin; the legs losing the power to hold the body, the worm easily falls down if only touched, it becomes soft and flabby to the touch. The bacillus attacks not only worms but larvae and moths, lurking for a while in the body after contagion.

The second microbe is a streptococcus which is round and has a diameter of 0,9μ. If exists in the connection of two or several individual with each other. These bacteria do not cause such a severe malady as the ones just mentioned. The diseased worm presents the first disorder after the great many multiplications of the microbes in the mucous membrane of the alimentary canal. It injures vigorous worms but little, but on account of its causing a formidable malady to the weak ones, often a great many of them are suddenly condemned to death.

The symptoms of the disease vary according to the period attacked, worms stricken with this disease after their moulting ramain small and lose their vital aspect; those attacked with it during the active period of feeding also remain small and finally

die or the fore part of the body is swallen up and becomes transpearent and the end part shrinks into a remakably small compass. The streptococcus attacks worms at any stage but it especially injures them before moulting.

By the following directions the rearer can prevent the disease :—

(1) By the disinfection of the silkworm chambers and instruments.

By disinfecting of the silkworm chambers and instruments any bacteria left are destroyed.

(2) By the selection of healthy seed.

On account of the fact that vigorous silkworms are little attacked by the disease, healthy seed is selected and protected completely.

(3) Precautions during breeding.

A proper temperature and moisture are kept, good ventilation is indispensable in the nurseries; that a proper quantity of food be given to the worms; of course the affected or attacked silkworms are taken out and the removal of the litter is often practiced.

5. The "Uji" disease.

This disease is caused by the parasitic growth of a insect called Ugimiya (Crossocosmia) sericaria Rondani. This parasitic maggot caused great damage to our sericulturists. The cause of the disease is due to the worm's swallowing the eggs of the fly which are laid on mulberry leaves. The fly lays eggs between the middle and the later of May on mulberry leaves

Ugimiya (Crossocosmia) Sericareae ROND.

which are given to the worms after the third age. The female and the male imago of the maggot are different in size; the male is 15 mm. in length and its wings are 30 mm. in length and female 14 mm. in length and its wings 28 mm.. The body is blackish brown and covered with coarse hairs. We always find some seven or eight thousand eggs in the female body among which several thousand eggs are actually laid. The female flies do not lay their eggs in any one place but in so many places that the number of eggs laid on one mulberry leaf being only one or two, at most seven or eight, thousand of the leaves receive the eggs of only a single female fly. The egg is black and shiny and has the marks of a regular hexagonal shape, like the meshes of a net. The form of the egg is an elongated oval, its length is 0,33 mm. and its width is 0,2 mm.. As soon as the egg is laid, its nucleus begins to develop and finally hatches into a tiny larva soon after it is swallowed by the poor worm. The larva or maggot escapes into the body space through the wall of the alimentary canal and finally invades a ganglion. The time from the hatching until it reaches this stage, is only one hour. Thus the maggot lives on the ganglion and after one or two weeks it comes out again into the body space and remains in the inside of a stigma, turning its hind end to the stigma and stretching its mouth into the interior of the body. In this position, the maggot grows adsorbing the nutrient from the diseased worm. After the maggot continues one to three weeks in this state, it matures and leaves the patient, that is ten to fourteen days after the worms has spun a cocoon. Either when the worm is attacked with the disease while it is young or when it is injured by several maggots, the worm is killed before it spins a

cocoon. The mature maggot is of a cylindrical form whose one end is round and the other pointed, it is yellowish white, 20 mm. in length, 6 mm. in width and consists of 12 segments. It moves very actively and lies low in the ground escaping out of the nurseries through a narrow space. The maggot that has thus buried itself in the ground, changes into a chrysalis whose puparium is a blackish brown and elongated oval. Passing the winter in earth, the maggot re-appears as an imago or fly in the middle of April, of the next spring. Many of the flies swarm about mulberries and lay eggs on the leaves which repeat the same cycle.

The worm attacked with the disease presents different symptoms. In the case of an attack by a single maggot, the silkworm has every appearance of good health and accomplishes all the stages but after pupation, the stigma of the pupa is always black and it can never change into a moth. On account of this fact, the parasite causes a serious damage to our egg producing. Either when the worm is stricken with this disease while it is young, or when the worm is attacked by several maggots, it presents such sysptoms as *Tarcko* (the hanging worm) that means the worm which hangs down on the edge of the tray and dies, *Kubimagari* (the worm benting its anterior parts) or sometimes *Hadaka-sanagi* (the naked pupa) that is the pupa which does not imprison itself in a cocoon.

In order to prevent this disease the rearer should take the following measures:—

(1) The maggots which come for the from cocoons should be killed.

(2) The rearer should sweep and dust under the floors of the mulberries after the breeding is finished and destroyed the puparium of the maggot which lies low in the ground to pass the winter.

(3) Mulberry leaves which are suspected of carrying the eggs of the fly should not be given to silkworms and especially the leaves should be carefully selected to feed the worms of the fifth age.

CHAPTER VII.

MANUFACTURE OF RAW SILK.

I. Reeling Methods.

There are three principal methods of reeling cocoons here, at present, "*hand-reeling*" (*Te-guri*), "*sedentary reeling*" (*Za-guri*), and "*machine-reeling*."

There was the "*flapping method*" (*Tata-ki-dori* or *Dōtori*), which is the most primitive one for reeling and now out of use. The method of *hand-reeling* is its improved form which is used in some remote districts; then comes the *sedentary reeling* which prevails in many parts of Japan; the most improved method is that of *machine-reeling*; the method called "*foot-reeling*" (*Ashi-bumi*) is a combined form of the *sedentary* and *machine-reeling* methods. The *hand-reeling* and the *sedentary reeling* methods have come down to us from ancient times, but *machine-reeling* was introduced from Italy and France about fourty years ago.

Details of these methods are as follows:—

1. Hand-reeling (*Te-guri*).

In *hand-reeling*, there is a reel which is revolved by a rod with the right hand of the reeler, and a pan is used for both the boiling and the reeling of cocoons. The index-finger and the middle-finger of the left hand serve for twisting the silk threads; of course we can get only two or three twists in this.

way. The reeler, in this case, has to stop the work as soon as the filaments are broken and she can reel only one thread at a time. The raw silk produced by this method is course and does not have the uniform denier.

2. Sedentary reeling (*Za-guri*).

In this method only one pan is used for the boiling and the reeling of the cocoons, as in the case of *hand-reeling*. The reeler can, generally reel only one thread at a time, but some can reel two threads at a time, though this is rarely the case. The reeler must determine the nubmer of filaments which she will attach to a single thread; the number varies according to denier of the silk thread. The cocoons are first boiled, then the true uniform filaments are found out. The required number of them is passed towards the angular point of a brass wire which is kept just over the pan, then it comes into contact with folded hairs which are fixed to a short wooden post, both for the purpose of uniting the filaments and also for getting rid of the water from the raw silk. Then the thread passes through a bamboo stick which moves to and fro and thereby prevents the thread from accumulating on a part of the reel, and at last it passes to the reel. Sometimes the Kennel system is adopted in this method for twisting and uniting the filaments.

By this method, the reeler can work without stopping operations for the reason that she can add a new filament by means of her right hand when one filament is broken, while her left hand is engaged in revolving the reel by the handle which is fixed to the wheel. Of course, by this method, the production and quantity of the raw silk are better than in that of *hand-*

reeling, but it is by far inferior to those varieties of raw silk produced by the *machine-reeling* method.

3. Foot-reeling (*Ashi-buni*).

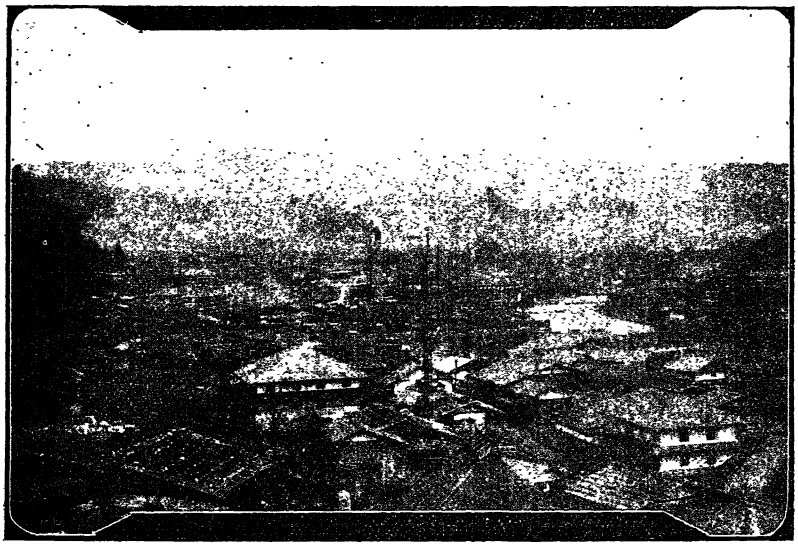
In this method, there is only one pan for the boiling and the reeling of cocoons, and not two as in the case of *machine-reeling*. The water is heated by a charcoal fire. The operation of reeling by this method is similar to that of the *machine-reeling*, except that the reel is revolved by the feet of the reeler.

4. Machine-reeling.

The *machine-reeling* method is quite different from that of *hand-reeling*, and the *sedentalry reeling*. There are prepared two pans, one is for the boiling of the cocoons and the other is for the reeling, and the reels are revolved by mechanical energy. By this method, we can produce a superior grade of raw silk, as the cocoon filaments are well united by complete twisting, and both the hands of the reeler can be devoted to the throwing of filaments to manitain the continuons uniform denier of the raw silk.

The energy used is of several kinds, human labor, water power, steam power, and electricity. The human labor is used in very rare cases and it will be gradually decreased. At present, most of the filature works use steam power; electric power is not used so much but it will be introduced into the filature works in the near future on account of its cheapness.

There are two systems of reeling by machines, one is the Kennel system and the other is the Chambon system. The former was introduced from Italian filature factories and latter



FILATURES AT SUWA, NAGANO PREFECTURE.

from France. And there is another from of twisting apparatus which is modified from the Kennel system and it is called the *Inazuma system.* Most of the filature factories of Japan have adopted the Kennel system, and the Chambon system has been adopted in a few filature factories in which a very fine or superior raw silk is produced, but it is more difficult to reel by this system than in the case of the Kennel system. Well united superior raw silk can not be produced by the *Inazuma system* and most of the factories have been converted to the use of the Kennel system, so we can see it but rarely now.

There are two kinds of reels in the *machine-reeling* system, one is for "*double reeling*" (or reeling with small reels) and the other is for "*direct reeling*" (or reeling with large reels). All the fllatures adopted the *direct reeling system,* when the

machine-reeling method was introduced from Europe, but the result was not so good. The managers of filature factories perceived, after many experiments, that the *direct reeling* method is not suitable here, on account of the humidity of the Japanese climate. So, they changed it to the *double reeling system*, though it required much more expense for changing the system.

There are many defects in the raw silk produced by the *direct system*. As the climate of Japan differs from the Continental climatic conditions, the raw silk round on the large reels does not dry well, and it does not unwind freely again, as its different parts stick to one another when they come into contact with the frame of the reel and harden when they become dry. Besides, it is difficult to keep the uniform denier of the raw silk in all its parts, because we examine the denier of the raw silk only at the time of reeling and the worker becomes careless for the maintenance of an uniform denier. These defects can be avoided to some extent by the *double reeling system*.

The number of the silk threads which are reeled by a reeler at a time is not the same in all cases. In the Chambon system a reeler can reel two threads only, but in the Kennel system she can reel two, three, or four threads according to the silkfulness of the worker. Generally, many filatures adopt the *two-thread-system* at the Kennel method.

Also, there are several methods of reeling cocoons. Generally, cocoons float on the water while being reeled, but there is another method in which they are forced to sink in the reeling water, and then reeled. The cocoons are boiled and reeled by the same reeler though rarely different persons are

employed for the two purposes. When the European reeling method was introduced into Japan, the latter method was adopted in all filatures as in the case of European filatures, but the result was not good because quarrels arose between the reelers and those who boiled the cocoons.

There are two methods of arranging the cocoon filaments in the reeling pan; in the one method, in the first place, the true uniform filaments are found out and kept in the reeling pan and then thrown up at the time of reeling, but in the other method, only the ends of the filaments are gathered, not arranged uniformly, and in the course of the reeling itself the reeler finds out the uniform filaments and throws them up without stopping the revolution of the reels.

The raw silk produced in the former method is superior in quality, but much more silk can be reeled in a certain time by reeling by the latter method, but the silk so produced shows some inferiority in its quality. Most of the filatures prefer the latter method, reeling silk of medium quality.

II. Machines and Instruments.

Reeling machines can be divided into two kinds, i.e., reeling and re-reeling machines.

Reeling machines include *flapping reeling* (*Dō-tori*), *hand-reeling* (*Te-guri*), *sedentary reeling* (*Za-guri*), *foot-reeling* (*Ashi-bumi*), and *machine-reeling* (*Kikai-dori*).

There are three ways of re-reeling, (1) by pulling (*Sha-kuri*), (2) by turning with the hand (*Temawashi*), and (3) by the use of a machine.

Different kinds of energy can be applied to these various kinds of machines. The implements for the *Dō-tori* method, *hand-work* method, and the *sedentary reeling* method, are turned by hand and that of the *foot-reeling* method is revolved by the reeler's feet. These implements serve to assist in the home industry of our country, but in all filatures, machines are used for reeling silk, whose motive powers are produced by water, steam, or electricity.

The wooking and mechanism of each of these instruments and machines is as follows:

A. Reeling Machines and Instruments.

1. The Frapping reeling instrument (*Dōtori-kikai*).

This instrument was prevalent from the most ancient times in Japan, but at present, there is no example of the use of it. The construction is very simple; it consists of a cylindrical piece of wood, which serves for the purpose of the reel, and a suppport, and an axis which is fixed to the cylinder. The cylinder is made of light wood and supported by the axis on the support and revolves round the axis.

The diameter and the length of the cylinder are about 5 inches and 2 feet respectively. The height of the stand is about 6 inches. The worker can not reel continuously with this instrument. At first, she must gather five or six filaments and twist them with her palms, then she turns the cylinder by frapping with her hand, and winds the silk on the cylinder, After reeling off the twisted part of the silk, she must stop frapping the cylinder and twist the filaments again, and so on.

2. The Hand-reeling instrument (*Te-guri-kikai*).

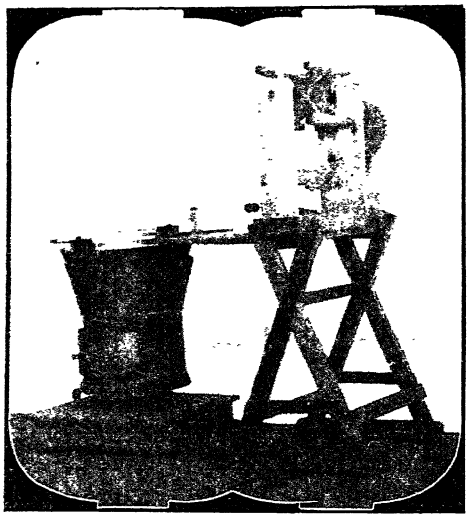
This is a little more improved instrument than that of the *frapping reeling*. About forty years ago, it was prevalent mostly in the mountainous and remote localities, but more improved instruments took the place of it, by and by, and it is used there only in rare cases at present.

The construction of the instrument is very simple and it consists of a rectangular reel and its stand. The circumference of the reel is nearly $2\frac{1}{2}$ feet. The reel revolves round on axis which is on the stand; the cross section of the stand is $1\frac{1}{2}$ inches square; the length of the stand is fitted according to the height of the reeler who reels while sitting down and the length and the breadth of the base or support of the stand are 8 inches and 1 foot respectively.

The reeler turns the reel by putting in a bamboo stick, whose length is about 1 foot, between the frames of the reel by means of her right hand, while the left hand is enaged for the purpose of twising the cocoon filaments.

3. The Sendentary reeling instrument (*Za-guri-kikai*).

This instrument is more improved than that of the *hand-reeling* and it is used in many parts of Japan as an important instrument of house-industry. There are two kinds, one is the *Zyo-shiū-za-guri* (which means the one that prevails mainly in the Zyo-shiū district), and the other is the *Ōshiū-za-guri* (which means the one that is prevalent chiefly in the Ōshiū district). In the former, the reel is revolved by means of toothed wheels and in the latter two wheels and a belt are used. In both of



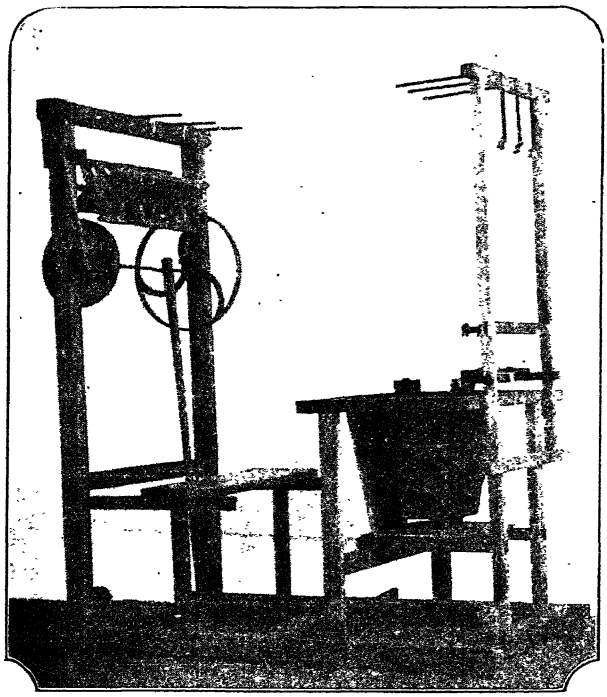
The Sedentary reeling machine (*Za-guri.*)

them, several kinds of apparatus for reeling silk are prepared as follows; (1) A bamboo stick which moves to and fro and over which the silk is made to pass, and then wound uniformly round the reel; (2) Folded hairs which are fixed to a small wooden post and serve to unite the filaments; (3) The brass wire which has the form of a V at whose angular point filaments are to be projected; (4) The rectangular reel whose circumference is 1 foot and 9 inches.

The reeler turns the reel by the handle which is fixed to the large wheel with her left hand and she uses the right hand to adjust the filaments, so as to maitain the denier of the raw silk.

4. The Foot-reeling machine (*Ashi-bumi-kikai*).

This is a simple machine which is a combined adoptation of the reeling machine with the *sedentary* instrument. It consists of a reeling table, a reeling holder, and several utensils for reeling silk. The table and the reel holder are connected. On the reeling table, a detachable iron pan is placed which serves to



THE FOOT-REELING MACHINE (*Ashi-bumi.*)

boil and reel the cocoons; two or three porcelain bottoms which have very small holes, are fixed in the twisting apparatus in one horizontal line upward a few inches from the pan, and they are used for the purpose of avoiding nobs of the silk, getting rid of water from the filaments, and collecting the filaments which go to form a silk thread. Besides, there is a twisting device which is an aboptation of the Kennel system.

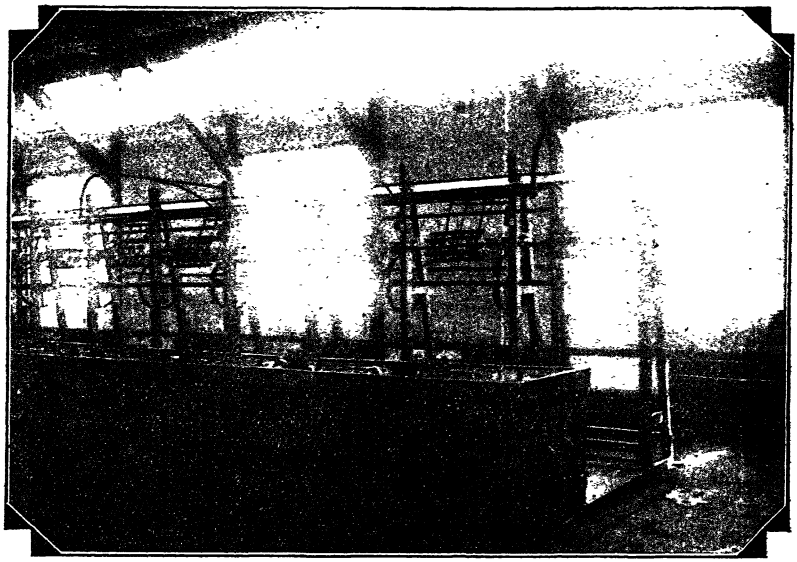
In a part of the holder, there are; (1) Two wheels, one is very large and the other very small whose diameter is about one tenth of the former; (2) The axis of the reels; and (3) *Aya-furi* which are small pieces of wooden or iron posts fixed on the top of the reel holder, but which move to and fro, and which have glass or enameled iron round hooks in their ends. The *Aya-furi* has to prevent the silk thread from accumulating too much on

any one part of the reel. The small wheel revolves round the wooden rod which is the axis of the reels also, and the axis of the large wheel is connected by wooden rod to the wooden plate which is to be moved by the feet of the person reeling the silk. The small wheel is in close contact with the large wheel just above it, and when the large wheel turns by the wooden rod which is set in motion by the foot of the reeler, the reels revolve as the small wheel also is turned, because it is in close contact with the larger as has been already stated.

By using this machine, both the hands of the worker are at full liberty to throw up the cocoon filaments, and at the same time her feet serve to assist in the turning of the reels. The filaments which go to form a silk thread, first, pass through the hole of a porcelain bottom and are twisted by the twisting apparatus, then pass through a hook of the *Aya-furi* and go to the reel.

5. The Reeling machine.

This is one that modified from the European silk reeling machine. It consists of two parts; a reeling table; a reel holder. On the reeling table, there are two basins and two pots for each worker, one of these basins serves for boiling the cocoons and the other for reeling. To both the two pans, water and steam are conducted by means of pipes. The pots are used to hold water and to contain the waste silk or chrysalis after they have been reeled off their filaments. Besides there are the porcelain bottoms and the twisting apparatus which are of three kinds, namely the Kennel system, the Chambon system, and the *Inazuma* system.



FILATURE.

In a part of the reel holder, there are the large and the small wheels which are in close contact with each other; the axis of the reels being fixed to the smaller one, and the shaft to which the large wheel is attached; the contrivance to stop the revolution of the reel; and a iron or wooden rod which moves to and fro, and to which three or four glass or enameled hooks are attached (*Aya-furi-ki*).

There are two kinds of reels in this machine, one of which is small and the other large. The former serves for the *double reeling method* and the latter for the *direct method.* The number of the reels for a reeler varies according to the number of the silk threads to be reeled by the reeler at a time. Generally it is two, three, or four, but sometimes there are

six, eight or even twenty for a reeler according to the construction of the machine.

In the construction of the reeling machines, different kinds of materials are employed in various ways, wood entirely; iron; and partly iron and partly wood, etc.

B. Re-reeling Machines and Instruments.

1. The re-reeling instrument by pulling (*Sha-kuri*).

This was prevalent from earliest years in Japan, but it was very incompletely constructed, as the apparatus to wind the silk on the reel uniformly was not yet prepared.

The construction is very primitive. It consists of a long reel and its support. The length and circumference of the reel are nearly 6 feet and 4 feet respectively. The height of the support is about 4 feet. At one end of the reel axis, a small handle is fixed and on the handle a rope is tied, its length being 3 or 4 feet. The reel is revolved by pulling the rope by the hand of the worker and the manner of pulling is said as *Sha-ku-ru* in Japanese, so this instrument is called *Sha-ku-ri*.

2. The Hand-re-reeling machine (*Te-mawashi*).

This is a more improved one than the first, and it is used much by sericulturists who manufacture silk in their houses.

The machine consists of a reel and the holder of the reel. In the holder, there are several apparatus; they are (1) wheels, (2) contrivances to stop the revolution of the reel, and (3) the *Aya-furi-ki*. At the end of the large wheel, a handle is attached by means of which the reel is turned with the hand of the person operating it.

The form of the reel is rectangular or hexagonal, and its length and circumference are $1\frac{1}{2}$ feet and 5 feet respectively. Generally, there is only one reel but sometimes two or three reels are used in one machine and that rather rarely.

3. The Re-reeling machine.

This is the most improved one for re-reeling silk, and several mechanical powers are used as its motive power, that is to say, water, steam, or electricity. It is constructed on a large scale in filature works, and in one machine from twelve to twenty-five, or even fifty reels are placed continuously in one line or double lines. The steam pipe is laid in front and under or behind and above the reels. The diameter of the steam pipe is from 2 to 4 inches and it serves to dry the silk on the reels while in the process of re-reeling. The materials used in the construction of the machine are of various kinds; (1) wholly wood, (2) wholly iron, (3) partly wood and partly iron. The *Aya-furi-ki* is of the same sort as that used with the reeling machine, and usually one *Aya-furi-ki* is prepared for each reel, but sometimes for the whole line of the reels, one *Aya-furi-ki* only is constructed.

C. Cocoon Drying Chambers.

Cocoon drying chambers are generally of two sorts: one is used for drying cocoons by heat and the other by steam. The former is called the cocoon desiccator by means of heat and the latter the cocoon desiccator by steam.

Now we will explain the principal parts of the construction of the cocoon desiccator which is popularly used now-a-days.

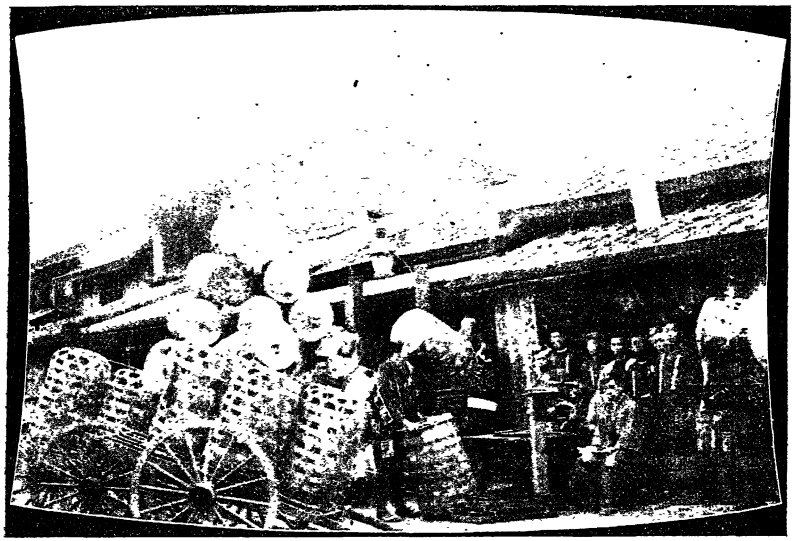
Among desiccators of the first kind we find *Nishigahara, Taniguchi* and *Nakahara systems*. The *Nishigahara system* is the most widely used among all of them, so that we will describe its principal parts below.

This system was designed in 1898 in the Tōkyō Sericultural Institute. The desiccating chamber is of brick work. The inner side is seven feet in height, an entrance is made on one side and a fire grate is opened on the front side which is connected with iron pipes of a 山 shape under the floor of the chamber. The ends of the iron pipes are connected with each other and open into a chimney above the fire grate. The external air is circulated into the chamber through the holes opened in the wall. The air thus passed in is warmed by the heated iron pipes. The floor of the chamber is made of an iron plate which we call the "*obstructing heat plate.*" On the iron plate, clean sand is placed one and half inches deep. On the wall that touches the behind part of the iron plate, innumerable small holes are opened which we call the "*radiation-hole.*" In the chamber a frame work is made for the reception of cocoon trays which are made as deep as the thickness of one and half cocoon. In the front part of the chamber, another plate is prepared to lead out the waste hot air, which is circulated in the chamber, through "*ejecting hole*" in the upper part of the wall to the chimney where the air leaves the chamber.

Among the second sort, *Ito, Minorigawa* and *American systems* are best known. The last one is most widely applied for operators upon a large scale.

III. The Cocoons.

It is hardly necessary to say that the utmost care must be taken in selecting the best cocoons, as the quality of the raw silk greatly depends upon them. Their handling, however, is



Buying of Cocoons.

not less important in obtaining a good grade of raw silk, as even the best cocoons are very often spoiled by improper handling. The method named below is considered to be a good practice.

A. Handling.

The live cocoons and the dry cocoons are handled in different ways, of which here we explain how to handle the live ones.

As soon as the live cocoons are taken in hand, they are classified, according to their quality and stored in proper places. Should they need stifling and drying, they must be placed in the drying room at once or, if necessary, forwarded to other places without delay.

When the live cocoons are to be left without treatment, they must be put in the cocoon trays, placed one over the other ; or they must be piled upon the wooden floor or on the waterproof papers, to the height of about three inches in the former case and about one foot in the latter.

When a considerable amount of cocoons are to be stored for a comparatively long time, the room must be provided with shelves, on which the cocoon trays may be so placed that the air passes freely between the cocoons and prevents them from getting roasted.

The cocoons with dead worms inside, or discolored cocoons very often spoil the other good ones near them so that the bad must be picked out carefully and must at once undergo the process of stifling and reeling.

The live cocoons are to be classified, according to their quality: the lustre, the size, the thickness of the layers and the difference in their moulting periods being taken into consideration. Usually they are classified into two or three groups.

The cocoon crop comes in at a season very limited in its duration, so that when cocoons are wanted in any quantity, they must be purchased very quickly and stored with the greatest care possible. Very often the best kind of cocoons are handled improperly and the result is that they are invariably attacked

by maggots, or mould and the best grade of good silk will never be unwound from them.

When a large quantity of live cocoons are purchased, it is better to stifle and dry them first and then store them. But as quickness is essential in handling the live cocoons, they should preferably be stifled and dried at the same time and stored immediatly afterwards.

Here we are going to explain how to stifle, dry and store the cocoons in which the drying machines, etc. will be touched upon at the same time.

B. Stifling.

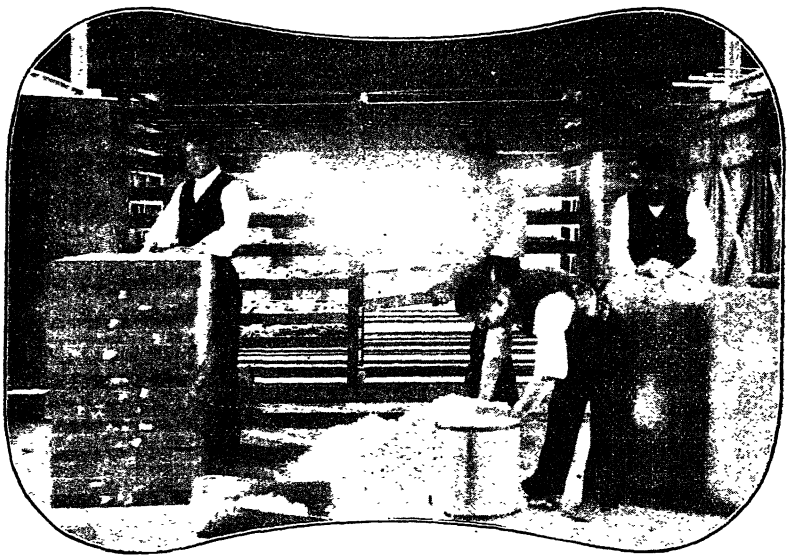
The object of stifling consists of killing the pupae inside the cocoons before they appear as moths and at the same time, the killing of the maggots that are parasites in the silkworms.

The proper time for stifling and the methods are as follows:

Stifling must be done immediately after the silkworm has spun the cocoon, that is, within seven days after the *mounting* in the case of the *spring* breed and five days in that of the *autumn* breed. If stifling is too early, it may kill the silkworm before he has finished spinning or even if it has already changed into a pupa by that time, its skin may be so delicate that it may easily break open during the treatment and spoil the inside of the cocoon. The damage from this cause is the greatest when the worms are just changing into pupae.

The methods of stifling are different but the essential thing is to keep the cocoon layers in a perfect condition and to get through with it as quickly and as economically as possible.

Three methods are generally used, i.e., "*steam-stifling*," "*dry stifling*" and "*steam and dry stifling*." In a wet country like Japan, the *dry stifling* is preferred to the others.



Cocoon drying.

C. Drying.

The object of drying is to drive out the moisture from the body of the pupa after stifling and to keep the characteristric nature of the cocoons for an unlimited period. Below are explained some methods of drying and also the care to be taken during the treatment.

There are two ways of driying, i.e., the natural and the artificial methods of drying. In the natnral drying the cocoons are dried by the circulation of the air only, while in the artificial method they are dried by heat and consequently this saves a great deal of time.

Although the natural drying is very simple, it takes a longer time, a considerable amount of room, and more hands to do it, thus making the expense of drying much higher, and moreover it spoils the lustre of the thread and makes the reeling a good deal harder, moreover the cocoons are apt to be attacked by mould, not to speak of rats and mice and certain insects. To put an end to these difficulties, the system of artificial drying was devised.

The most essential part in drying is the circulation of the air in the drying chamber. When the air is saturated with the evaporations from the body of the pupa, it needs frequent thanging, otherwise, the drying with never be done successfully. Although the time needed in drying greatly depends upon the temperature, it is not less affected by the humidity which in its turn is lessened greatly by the circulation of the air. So during the drying the air must be changed as much as the necessary temperature of the chamber permits.

D. Storing.

The object of storing is the keeping of the cocoons from getting wet again after drying and to keep them from the attacks of vermin such as rats, mice, insects, bacteria and vegetable mould.

The process and care necessary in storing are explained belows.

There are three ways of storing; by bagging, by canning and by storing in a warehouse.

(*a*) Bagging: About one *koku** of the cocoons is put in a bag made of thick paper and then sealed and the bags are stored in piles in an ordinary storehouse. These bags are to be treated with *Shibu-kami* or waterproof paper to keep the moisture out.

(*b*) Canning: About five *to*† of the cocoons are put into a tin or zinc can and the cover is put on tight and the cans are hermetically sealed. They are also stored in piles in a storehouse or in any kind of room.

(*c*) Storing in a warehouse: The entire storehouse is divided into compartments of about one hundred forty-four or one hundred eighty square feet each. The four sides and the top and bottom are protected by zinc plates, the joints being soldered tightly and the bags are piled in good shape. The cocoons are put in paper or cotton bags and placed in the sections.

Special attention must be paid to the location of the storehouse, which must be built on dry soil and its construction must be tight enough to keep out the moisture. If possible the house should be built on a high place, otherwise it may be necessary to raise the ground by filling in so as to get rid of the dampness.

Cocoons must not be put in a storehouse before the final drying. When they are brought in, they must be dried until they reach the weight which perfectly dried cocoons ought to have.

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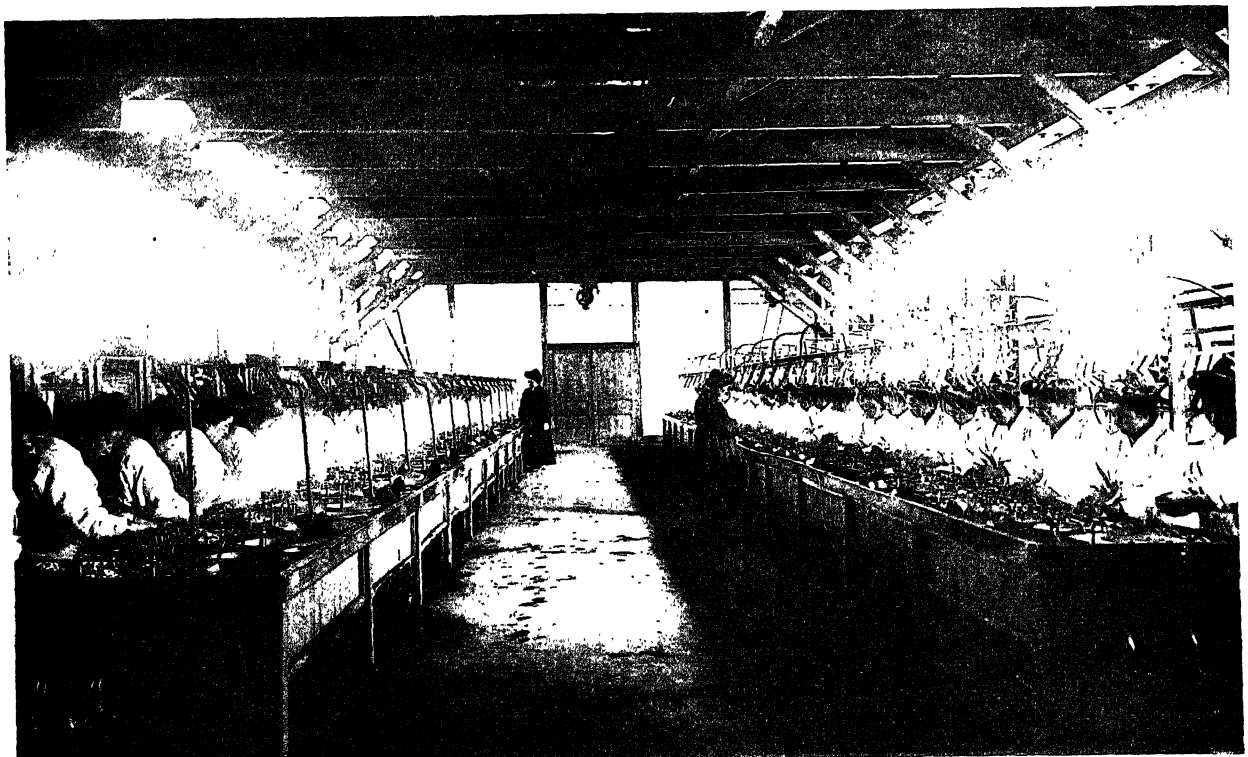
* one *koku* of live cocoons weighs about 375 kilograms.

† one *to* of live cocoons weighs 3.75 kilograms.



RAW SILK REELING.

IV. Reeling.

The process of drawing silk thread from the cocoons is called reeling. The amount of silk thread drawn differs more or less according to the quality of the cocoons, but usually we get about ten *monme* of silk thread from one *sho** of cocoons (about 270 to 280 cocoons) and a reeler reels about eighty *monme* of silk thread in a day of ten working hours.

A. Cooking.

With the object of softening and dissolving the gelatinous substance, *sericin*, in the outside layers of the silk thread, which makes them stick to each other, the cocoons are cooked.

The cocoons are so placed in a basin, filled with water to about eight-tenths of its depth, that they cover the surface of the water. The cooking is done by raising the temperature of water gradually, first wetting the surface of every cocoon in the basin by stirring. Care must be taken not to actually boil the water while cooking. The boiling of the water causes some of the cocoons to sink to the bottom and makes the reeling work somewhat difficult. Nor should the cocoons be stirred more than what is absolutely needed. Too much stirring is apt to cause much precipitation and also to waste much silk. If the cooking is over done, the thread obtained will be less in quantity and of a poor quality, although it makes the reeling easy, while under-cooking makes it hard to reel and the thread obtained will lack unformity in titre and will be full of knots. The proper degree of cooking is

* one *sho* of live cocoons weighs 375 grams.

the most important thing to consider. Of course, it depends upon the quality and the conditions of the cocoons, but, as a general rule, the best time to stop cooking is when the cocoons begin to be a little gray and they give a smooth and agreeably elastic feeling to the fingers, and the filaments are easily drawn from the cocoons.

B. Discovering the Filaments.

In order to draw out the silk threads from the cocoons without getting them tangled up, it is necessary first to seek the ends of the threads. There are two ways of doing this, according to the conditions of the cocoons at the time. The first method is applied to the new cocoons, that is, the cocoons from which no thread has yet been drawn. The cooked cocoons are stirred by a dipper handle or a stick and the thread-ends that float out from the cocoons are picked up by contact with it. The second method is applied to the "*lost thread cocoons*," the thread-end of which has been lost by its breaking off, while the reeling process was going on. For this purpose we use a kind of broom, made of rice ears, whose upper ends spread apart while the lower ends are tied together, thus making a broom shape. The cocoon surface is swept over slowly with this broom and the filaments are thus picked up by contact with it. In this second method, the basin must be filled with water and after boiling the water the *lost thread cocoons* are put in the basin and as soon as the cocoons start to rise up to the surface of the water, the boiling should be stopped and that will be the time to begin discovering the lost threads.

When the thread-ends are found by the above methods, the next thing is to find the true thread-ends. To do this, take the filaments thus sought in the left hand and shake them up about seven or eight inches above the surface of the water and after two or three trials of a general character, make the final search very carefully. And then after the waste silk in the hand has been put aside, the true thread-ends are put together and hooked to the hanger.

C. Reeling.

The reeling is to be done immediately after the cooking and discovering the true thread-ends is over. The cocoons are thrown into the basin filled with water at a temperature of of about 160° F..

A number of thread-ends drawn from the cocoons (the number being different according to the titre) are passed through a porcelain ring. After that, in the Kennel method, these threads are twisted after passing over the upper and lower rollers or, in the Chambon method, they are twisted first and then fastened to the reeling frame after passing through the guide rings and the hooks of the counter cranks. The thread is reeled up by revolving the frame. The speed of revolution must not be too fast, or the undoing of the cocoons can not keep up with the motion of the frame, which causes the thread to break off often, during the reeling and much time is wasted in fixing it, and moreover, this method gives the thread too many knots. But if the speed is too slow, a much less amount of thread is obtained, making the reeling more expensive and the thread drawn is slow in

drying which not only spoils its lustre, but causes the filaments to stick together. The number of the revolutions depends upon the size of the reeling frames, the number of thread-ends put together, the skill of the reelers, the quality of the cocoons, the titre of the thread, etc., but usually when an ordinary reeler is given ordinary cocoons and wants to reel the thread of the quality of fourteen denier with a *quadruple machine*, the proper revolutions per minute are believed to be 250 for small frames, and 100 for larger ones. The water must be changed from time to time during the reeling as dirty water spoils the lustre of the thread. In order to maintain the uniform titre of the thread, a new filament must be added every time the old one is about to end. To do this, pick up the cocoon to be added with the right hand, take hold of its thread-end with the left hand, drop the cocoon in question near the other cocoons from which the thread is being drawn, grasp the new thread-end with the right hand with its face down, hang the thread-end on the middle part of the first finger, and push it against the trunk thread with the first finger of the left hand, which is now placed outside of that of the right hand, cut the end of the new filament between the thumb of the left hand and the first finger of the right hand and at the same instant, turn the right hand face up, throw the cut end of the new filament against the trunk, about one inch below the porcelain ring and thus the addition of a new filament will be affected.

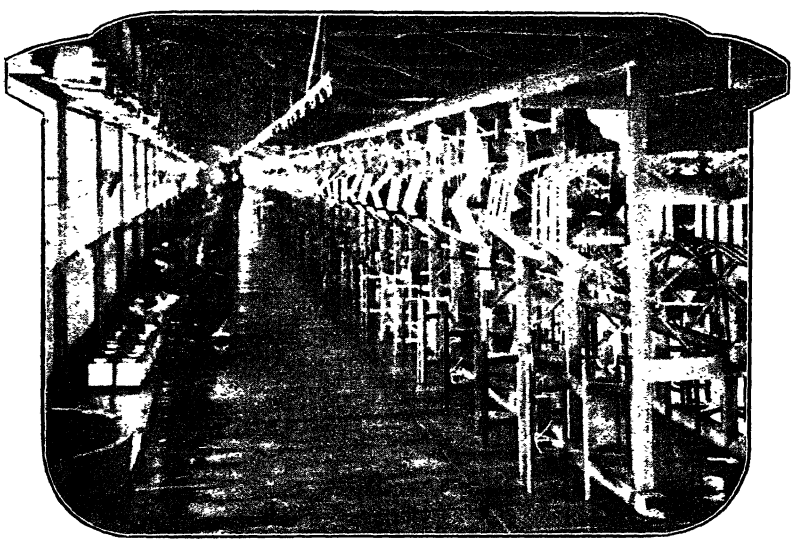
The number of twists taken gives not a little effect to the lustre and the sticking of the thread as well as to the working expenses. Too many twists make the work difficult

and lessen the strength of the thread, on the contrary, too few twists make the thread hard to dry, thus spoiling both the lustre and the adhesion of the filaments to each other. As a general rule, the proper number of twists for the thread of fourteen denier is about 300 in the Chambon method, and about 250 in the Kennel method, the length of a twist being about nine inches in the former and eight inches in the latter.

V. Finishing and Packing.

A. Re-reeling.

The reeling machine usually used in Japan is what is called the *double reeling system.* So after the reeling has been done, it is necessary to re-reel it into the skeins of the standard length.



Re-reeling.

The way to do this is to moisten a pretty well dried frame with water and place it vertically on the table in front of the re-reeling machine, and then hang the thread-end on the glass hook of the counter crank, after passing it through the guide ring and reel up the thread on the new frame. Or, in another method, the frame is hung horizontally on the supports, placed about from six to nine feet in front of the re-reeling machine and about five feet above the floor. The former is called the "*vertical method*" and the latter the "*horizontal method.*"

As the frame revolves, the thread is reeled up in a slanting direction on the frame by the action of the counter crank. Care is to be taken not to wet the entire frame before re-reeling, but just the corners. The revolution should be about 120 to 130 per minute and must be kept uniform during the re-reeling. Reel about ten *momme* of the thread on one frame. Usually a reeling frame of about five feet in the entire outside measure used, so that four skeins of silk thread are reeled on one is frame.

B. Drying.

When the thread is re-reeled, it is not easily taken off the frame, on account of too much moisture being contained in it. The threads are usually put in a special drying room before being taken off the frame, so as to dry them to contain just the amount of moisture, that is officially approved.

C. Inspection.

The quality of the raw silk (lustre, knots, strength, etc.) is affected by many causes, among which the principal ones

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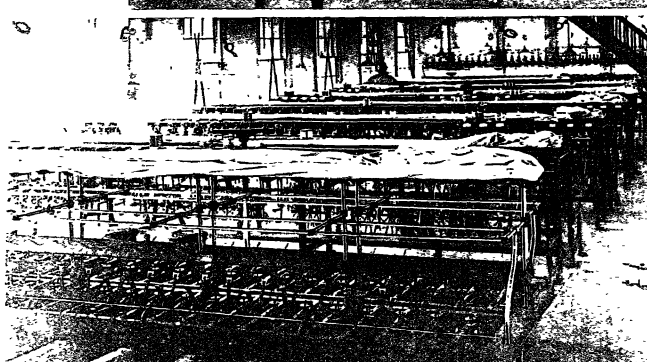
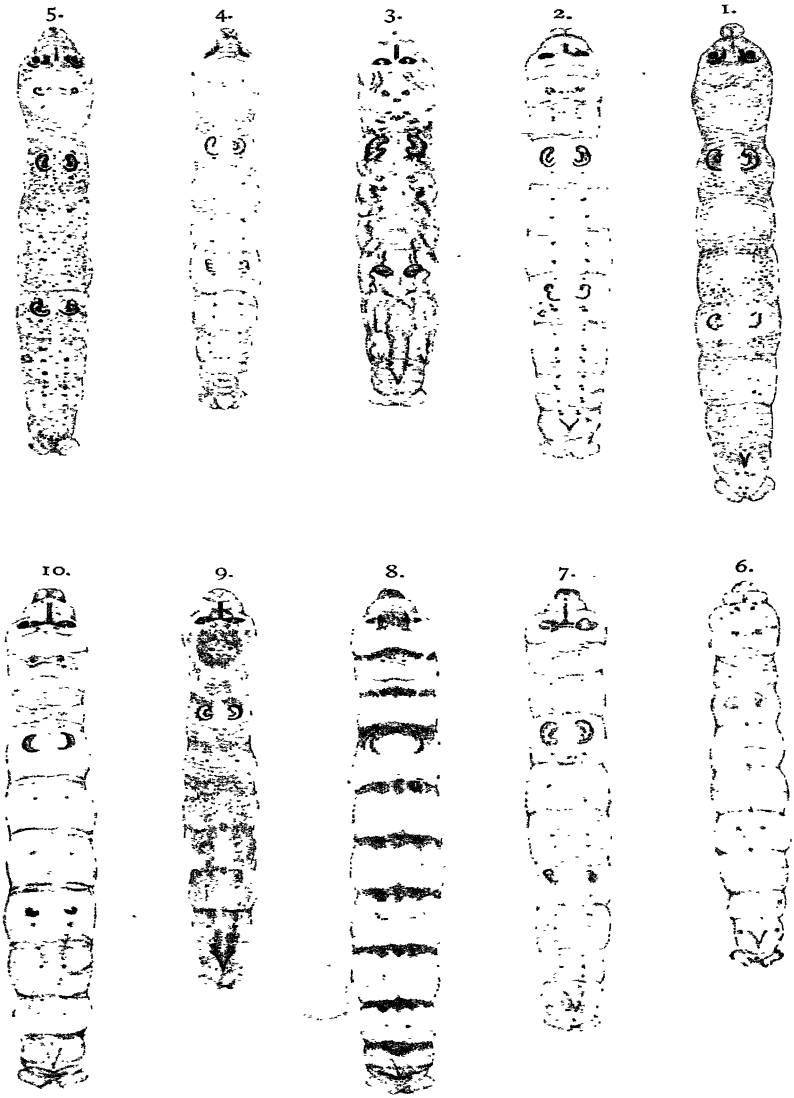


3.

Conditioning of Raw Silk.

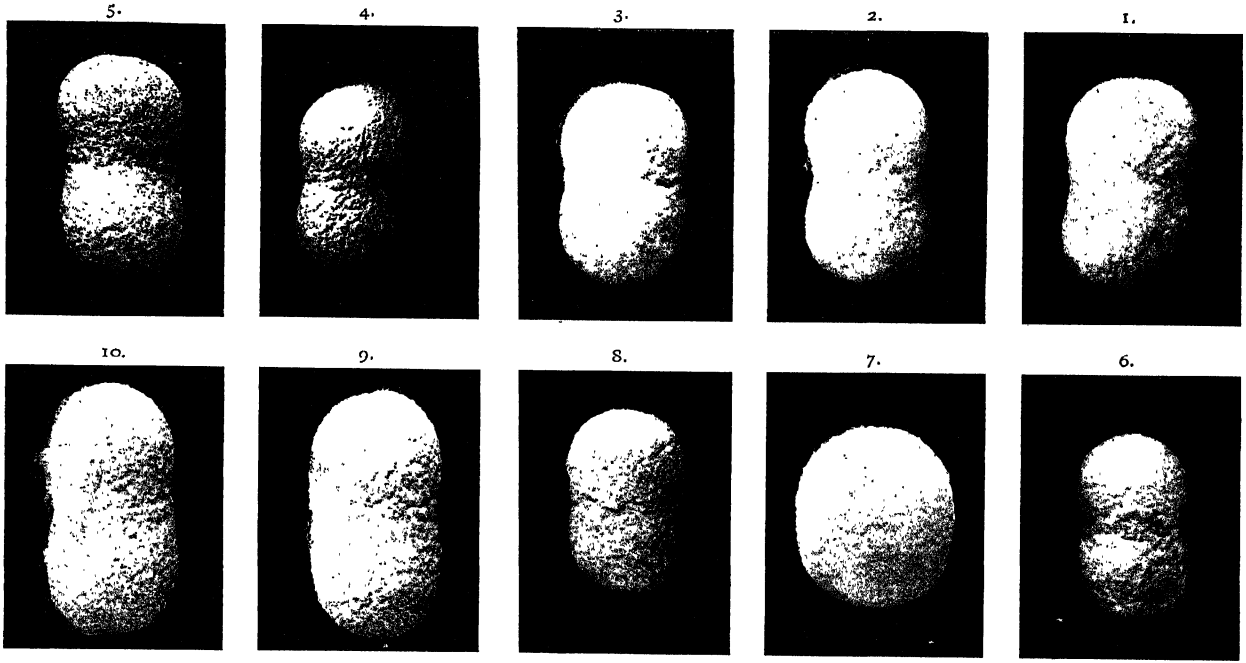
1. Conditioning Ovens.
2. Machines for testing the Sizes and the Winding.
3. Machines for testing the Cleanliness.

SILKWORM REARING.



VARIETIES OF SILKWORMS.

1. *Koishi-maru.*
2. *Ao-ziku.*
3. *Kasuri.*
4. *Kurohane-seihaku.*
5. *Araya.*
6. *Oniwaka-maru.*
7. CHINESE RACE.
8. KOREAN RACE.
9. FRENCH RACE.
10. ITALIAN RACE.



VARIETIES OF COCOONS.

1. *Koishi-maru.*
2. *Ao-ziku.*
3. *Kasuri.*
4. *Kurohane-seihaku.*
5. *Araya.*
6. *Oniwaka-maru.*
7. CHINESE RACE.
8. KOREAN RACE.
9. FRENCH RACE.
10. ITALIAN RACE.

are the quality and selection of the cocoons, the method of stifling and storing, the quality of the water used in cooking, etc.

The uniformity in titre depends greatly upon the skill of the reelers, the number of the revolutions of the reeling machine and the kind of machine used.

The lustre is inspected in a dark room specially made for this purpose, to which the light is admitted from the north window only, the other three sides being painted black to prevent the dimming of the reflection. Different manufacturers give different numbers of classes, but usually silk threads are classified into four or five grades according to their lustre. The silk of the fourth or fifth class is usually consumed by the local customers and is not exported abroad.

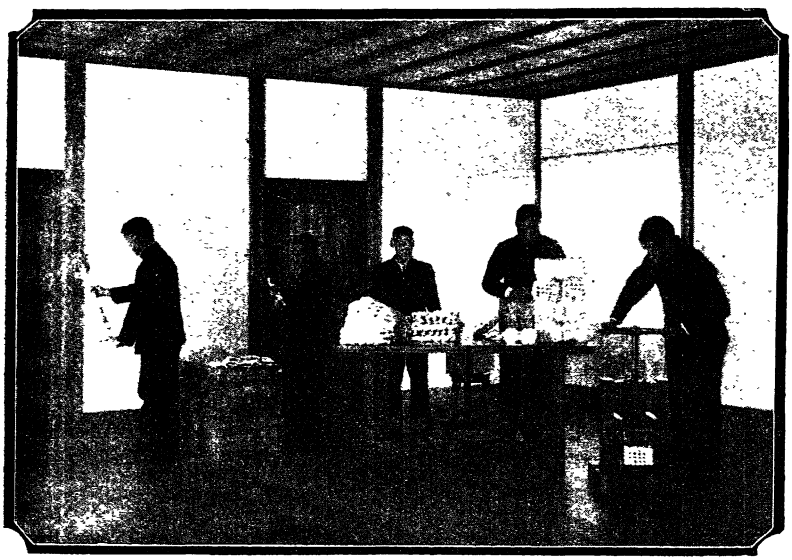
To inspect the titre, take about two hundred winds of the silk thread of the ten *momme* grade on a standard frame and after drying measure it with a special scale for measuring the titre. If it is detected that it differs by over three denier from what is wanted it is rejected for export purposes.

The inspection of knots is made at the same time with the thread reeled for measuring the titre, by looking over the thread on the frame. If it contains too many knots, rejection must follow.

The strength is tested by the serimetre, every time the silk thread is taken from the different kinds of cocoons. If the test falls short of the required strength, the silk thread must be rejected.

D. Dressing.

To make the handling and shipping easy the raw silk must be properly dressed. The first thing is to mark both ends of the thread on the skein, so as to make it easy so find them when re-reeling is needed. For this purpose, there are three ways in common use.



Finishing of Raw Silk.

(*a*) *Sukui-dome.* Only the outside end is fastened at the middle of the skein with a few threads. The objection to this method is that it is pretty hand to find the thread-end and especially when the first end is lost, it is impossible to find the other end.

(*b*) *Wa-dome.* Both ends are folded together four or five times and wound round the skein. In this method the

thread-ends thus fixed are apt to be broken while handling.

(*c*) *Wari-dome.* Both ends are folded together four or five times, twisted and pushed into the skein and fastened at one end of the skein after winding it around. This method seems to be most convenient for finding the thread-ends and they will not be easily broken while handling. The proper position for fastening the thread ends is between the corner and the middle part of the frame.

Two pieces of cotton yarn are used to keep the form of the skein. They are usually No. 42 *Sarashi-futako* threads and are sewed with five stitches across the skein and with five more in the opposite direction, i.e., about an half from the fastened thread-ends.

After the thread-ends are fastened, the skein is ready to be dried and dressed.

There are several ways of dressing up the raw silk skeins.

(*a*) *Teppō-zukuri* and *Sage-zukuri.* These two are very awkward to handle and the threads are easily tangled up, so they are not used at present.

(*b*) *Shimada-zukuri.* It has the same trouble as the above mentioned, so it is seldom used.

(*c*) *Orikaeshi-zukuri.* This method of dressing is used in Miyagi and Fukushima prefectures, and some of the export silk is dressed in this style. In this, a stick is passed through the ends of two skeins and supported by a pair of columns of about one-eighth of an inch

square and three inches high, standing on a board. The skeins are stretched out beyond another pair of columns on the same board and another stick is placed on the skein and the skein is folded on the stick. Then the stick at the other end of the skein is pushed into the first end and turned so to give a twist to the skein. After five skeins were dressed in this way, they are tied together with cotton threads. Even in this method, the threads are very often tangled up while they are being handled.

(*d*) *Nezi-zukuri.* This is the one in common use and the greater part of the export silk is dressed in this style.

Two iron needles are bent like fish hooks and fastened to a column by first attaching them to a thick board. Two skeins of the raw silk are placed side by side and a pair of bamboo sticks are passed through both ends of the skeins. The stick at one end is rested on the hooks on the column and the skeins are given some five twists by turning the stick at the other end. Then they are folded once and twisted again. Then the end held by the hand is forced into the other end. Care must be taken to give the proper twists. Usually in a skein of eighteen to nineteen *momme* the first twists are five and the last ones number three. After being thus dressed up, a brass needle is passed through the ends of six of these bundles, placed side by side. And the five of these are placed one over the other. Covers are put on and the whole mass is placed under a screw press and pressed down to a height of about four inches. After that the package is fastened by

threads at three places and put in a tough and smooth paper cover.

E. Packing for Shipment.

To pack the raw silk for the purpose protecting it from damage and making the handling easy, we usually wrap it in *Shibu-kami*, a sort of water-proof paper and then put it in oil paper covers. Fifteen or sixteen of these packages are placed in a box and the cover is put on tightly so as to keep out the moisture and insects. After the marks, numbers, and the address of both parties, etc., have been put on, ropes are put round the whole to prevent damage and then a straw mat is placed over it, and it is tied with some more strong ropes. The boxes used for this purpose are usually made of the three-quarters of an inch board of Japanese cedar or Japanese cypress. To prevent damages from friction, the inside is planed smoothly and one part of the outside of the box is planed to unite upon it the necessary formations. The board of the box must be fitted tightly and kept from breaking by the use of cross pieces on the outside.

The above is the way the local manufacturers ship their raw silk to Yokohama. For export, a little different way of packing is used. Twenty eight to thirty two packages of raw silk are put in a cloth bag and tied with ropes at two places. After the *Shibu-kami*, toughened paper and oiled papers have been used, they are again wrapped in two sheets of mats. The mats are sewed together and strong ropes are tied round them in every direction. And then the marks, numbers, addresses are written on the cover.

VI. Waste Silk.

A. Chappy Silk.

While searching for the true thread-ends, we get the thread from the coarse, loose outside layers surrounding the cocoon. This unreelable part is dried up and used as the raw material for silk spinning.

B. Floss.

This substance we get by stretching the unreelable part above mentioned before drying. Usually it is two and a half feet long. When it is about six feet long, we call it especially the "*long floss.*" To make this, stretch we take the wet chappy silk and tie it round two pillars of about a half inch square standing on a board. About twenty *momme* are taken off at one time, and dried in the sunshine. Twenty to thirty of these are put into a bundle and thirty of these bundles are made into a package. This floss is one of the best raw materials for silk spinning.

C. "Dohyō."

The innermost layers of the cocoons are not fit for reeling. These are dried and separated from the body of the pupa and used as a raw material for silk spinning.

D. "Furi."

To produce this take the innermost layers of the cocoons and dip them in water and separate the cocoon layer from the body of the pupa by stirring them with a bamboo brush. The

cocoon layers are washed in water several times and dried in the sun and thus we get what we call *Furi.* This also gives a good raw material for silk spinning.

E. The Snapped Unreelable Part of the Cocoons.

When we take the unreelable parts from the inner layers of the cocoons and boil them in water with the addition of some soda and treat them as mentioned in the previous article, then we get cocoon layers softened like silk cotton. This is also a good raw material for silk spinning.

CHAPTER VIII.

SALES OF RAW SILK.

I. "DZIYARI."

The sale of raw silk for home consumption is termed *Dziyari*. This is carried on either by direct dearing with silk producers, or through the medium of brokers. The raw silk used for home consumption is usually of an inferior quality or such silk as is suitable for the export trade owing to the amount produced being too insignificant, though it is of good quality. It may, however, be noted that the recent increase of the export of *Habutae* has causad a greater demand for raw silk for home consumption.

II. "HAMA-URI."

The raw silk destined for export is forwarded to Yokohama, the export market for silk, where it is sold off to the export merchants through the medium of the raw silk dealer. This kind of sale is termed *Hama-uri*, as it is effected at Yokohama. The greater part of the raw silk produced in Japan is sold off by this process.

A. The Process of Consignment.

The consignment of raw silk from the local silk raisers to the raw silk dealers at Yokohama is performed in two different ways ; one is by the method of unlimited consignment, the other

that of limited consignment. In the former method no restrictive condition is put on the consignee as to the mode of sale, quotation, or the time of such sale, while in the latter case, the quotation, time, and mode of sale must be strictly followed according to the instructions of the consignor. In this case, it is customary for the consignor to take from the raw silk dealer a note of consent to the conditions agreed upon, so that the consignor may be assured that the sale shall be executed in accordance with his desires. This method, however, has its defects in this point that the consignee can not exercise his own discretion, as in the case of unlimited consignment, as to the situation of the market and the most suitable time for effecting a sale, and naturally lacks the activity which is the most important factor in all business transactions.

B. The Process of Forwarding Raw Silk.

When any local silk producer wishes to send his silk to Yokohama for sale, he must first have his silk packed properly in cases, each containing some nine *kwan*, and have it forwarded by the transporter to any traustworthy raw silk dealer at Yokohama. In case the producer desires to get the money for the silk paid at once, he can do so by negotiating a documentary bill to the bank in his locality, to which he has to present the bill of lading together with the insurance policy on his goods. Though the value allowed for the documentary bill varies somewhat according to the credit the producer enjoys, the usual rate is 70 per cent. of the price of the goods to be forwarded. This having been done, the producer must send to the raw silk dealer the whole set of the documents, while the bank notifies its

correspondent bank at Yokohama of the completion of this process. Upon this, the raw silk dealer goes to the latter bank and receives the goods that have arrived there against the bill of lading and the decumentary bill, after paying the sum of money stated in the documentary bill and its interest. When the goods have been identified with those stated in the bill of lading, the raw silk dealer notifies the ower of the goods of the arrival of the goods, and then commences the process of selling the same at once. In case the goods received should prove defective or damaged, he must notify his consignor to that effect without any unnecessary delay.

C. The Process of Executing a Sale.

In selling raw silk to the exporter, the raw silk dealer sends his clerk to the exporter's or the exporter himself may come to the raw silk dealer's house, and make up some agreement there. When such an agreement has been arrived at, the raw silk dealer takes a few books of the silk to the exporter's as specimens, which are accordingly put under examination, and if they prove satisfactory, the exporter makes a provisional contract of purchase, fixing the price and quantity required. Upon this, both parties clap their hands by way of swearing to keep the contract. This is termed *Te-awase* (clapping hands). This done, the raw silk dealer sends the whole of the goods to the exporter's warehouse against the warrant. Then the exporter examines the goods comparing the same with the specimens offered. After the goods have passed this examination, the real contract is made, and then after weighing the whole of the goods, the exporter pays out the

price. Should the goods, however, prove inferior or defective upon examination, the contract may be cancelled and the goods be set back to the raw silk dealer, or be bought with some deduction on the price settled in the provisional contract, or in some cases, as is often done, the sale may be executed after discarding the defective portion.

D. The Examination of Raw Silk.

The examination of raw silk is chiefly carried on macroscopically, but mechanical examinations are often practiced such as the following operations :—

(1) Two twisted skeins are taken out of each case for each test.
(2) Twenty filaments out of each skein are put in test for size.
(3) The amount of silk wound and the number of breaks made in an hour should be examined.
(4) Tenacity and elasticity are put in test.
(5) The number of knots and knobs are examined.

In order to aim at accuracy in the examination and quickness in the transaction, the mechanical examination is generally requested to the Silk Conditioning House, and the raw silk dealer presents the certificate of such examination received beforehand from the Conditioning House in dealing with the exporter, or asks the Conditioning House for the examination of the raw silk after the provisional contract has been made.

E. Customs and Usages in Dealing.

Raw silk is usually sold by its net weight, but should it be observed to contain too much moisture, one half of the whole of

the goods is selected in the presence of both the exporter and the dealer, and sent over to the Conditioning House for examination. If the difference between the net and the conditioned weight be over 2 per cent., the dealing weight of the silk is determined by deducting the difference. The weighing at the actual delivery of the goods is termed *Kwan-kwan* (weighing). All the tare (basket, calico bag, wrapper, etc.) must be deducted from the gross weight according to their materials, and in the case of the cord used for making a book a deduction of 0.75 *kin* shall be made, any fraction below a quarter *kin* being cut off. A weighing charge of fifty *sen* per case is due to the weigher.

In the dealings of raw silk, no credit is allowed, and the goods are always delivered against cash. There is another mode of buying raw silk called the "*preliminary contract*," in which the exporter makes a *preliminary contract* of purchase with local silk producers through the medium of the raw silk dealers. The quality of raw silk, its price, and the date of delivery are all specified in this contract, and the contractors are bound to follow the terms without any variation whatever on account of the current price of the goods at the time of delivery.

F. Charges for Effecting a Sale.

The sale of raw silk for export at Yokohama requires these charges:—

raw silk

1.	1. 5% of the selling pirce	for selling commission.
2.	0.03 % „ „	for daily interest on documentary bill.
3.	¥0.12 per bale	for carriage.
4.	¥0.50 per bale	for weighing charges.

refuse silk:

1. 3,5% of the selling price — for selling commission.
2. ¥0.15 per bale — for carriage.
3. ¥0.275 per bale — for weighing charges.
4. ¥0.075 per bale a month — for storage.

G. Exporters and Dealers of Raw Silk.

Dealers of raw silk at Yokohama are as follows:—

Name of Company.	Trade mark.	Dealer.
Hara Gōmei Kaisha.	正	Tomitarō Hara.
Gōmei Kaisha Mogi & Co.	兌	Yasuhei Mogi.
Ono & Co.	合	Mitsukage Ono.
Shibusawa & Co.	㊅	Sakutarō Shibusawa.
Yokohama Branch of the Shinyei Kabushiki Kaisha.	㊇	Katarō Okumura, the Ciefe of the Branch.
Gōmei Kaisha Tanaka & Co.	㊄	Shinshichi Tanaka.
Watanabe & Co.	㊈	Bunshichi Watanabe.
Ogawa & Co.	小	Katsusaburō Ogawa.
Imai & Co.	合	Dirosaburō Imai.
Kimura & Co.	区	Riuyemon Kimura.
Kaneko & Co.	兼	Masakichi Kaneko.
Itō & Co.	㊀	Kinbei Itō.
Gōmei Kaisha Kojima & Co.	㊎	Genzaburō Kojima.
Yajima & Co.	家	Zenshichi Yajima.
Ōtani & Co.	㊅	Kahei Ōtani.
Wakao & Co.	命	Ikuzō Wakao.
Yamada & Co.	㊍	Komakichi Yamada.
Inouye & Co.	令	Sadakichi Inouye.
Nakazawa & Co.	今	Gosaburō Nakazawa.
Sasamoto & Co.	全	Toyojirō Sasamoto.
Okada & Co.	大	Shinbei Okada.

Name of Company.	Trade mark.	Dealer.
Abe Gōmei Kaisha		Taichi Abe.
Kakuwa & Co.		Zensuke Kakuwa.
Anzai Gōmei Kaisha		Tokubei Anzai.
Iwakura & Co.		Minoru Iwakura.
Ichihara & Co.		Matashichi Ichihara.

Exporters at Yokohama are as follows:—

Vivanti Bros.
Siber Wolff &'Co.
Sulzer Rudolph & Co.
F. Strähler & Co.
L. Mottet.
Jardine Matheson & Co.
Jewett & Bent.
Siber & Co.
Pila & Co.
Henri Pernardin & Co.
Vavier & Co.
Cornes & Co.
Otto Streuli.
Varenne & Co.
Carlowitz & Co.
Boyer Mazet Guilliee & Co.
C. Eymard & Co.
Nabholz & Co.
P. Dourille.
Herbert Dent & Co.
Montel & Co.

R. Schmidt Scharf & Co.
Langin & Co.
Yokohama Branch of Mitsui Bussan Gōmei Kaisha.
Yokohama Kiito Gōmei Kaisha.
Dōshin Kabushiki Kaisha.
Hara Gōmei Kaisha.

III. Direct Export.

The raw silk raised by local silk producers is sometimes exported through the medium of direct exporters at Yokohama.

A. The Modes of Direct Export.

The direct export of raw silk is executed by means of (1) consignment and (2) exportation to fill orders. In the former case, the producer entrusts the sale of his silk to the direct exporter fixing the destination of such export. In the latter, the producer sends abroad through the direct exporter his silk reeled in accordance with the order placed previously in his hand.

B. The Process of Shipping.

In the direct export of raw silk, the silk producer must first of all send his silk packed properly to the direct exporter at Yokohama stating its destination, who will accordingly examine the goods received against the invoice, and if he finds the goods in proper condition, he will notify the producer of their arrival. A close examination is then carried into operation on the quality of the silk, and an invoice is drawn up stating the

quality, quantity, and cost price, which is to be sent over with the goods to the branch offices of the direct exporter in America or France, and a duplicate of the invoice should also be sent to the producer for reference. The silk is so packed as to weigh some 150 pounds per case, classified according to its quality. In case the silk is to be exported to America, from one to four books togther with each invoice, must be sent in a separate bale as samples. The branch offices in America or France receive these goods and execute the sale properly.

C. Documentary Bills and Exporting Charges.

In drawing a documentary bill, the amount usually allowed for the silk intended for direct export is 80% of the current price of the silk plus the exporting charges. The silk that is sent abroad as samples is not idcluded in the documentary bill. The branch office abroad is notified of this amount after it has been converted into American or French currency according to the current rate of exchange of the bill four or six months after sight. At the completion of the sale, the branch office settles the accounts after deducting the value of the bill.

The charges for exporting silk to America and France are roughly estimated as follows:—

to America.	Packing and Shipping charges	¥2.00	per bale.
	Freight	$6.00	per 100 lbs. gross.
	Charge for consular certificate	¥5.02	per lot.
	Marine Insurance premium	¥0.50	per ¥100.

to France.

Packing and Shipping charges	¥2.00	per bale.
Fregiht	¥8.00—9.00	per 112 lbs. gross.
Marine Insurance premium	¥0.75	per ¥100.

D. Collection of Prices and Selling Charges.

As sale on credit is customary in the markets of America and France, the branch office of the direct exporter executes the immediate collection of drafts drawn at such sale, since the direct exporter will be held responsible for all losses that may be caused by the bankruptcy of the purchaser, or by unforeseen and unavoidable accidents. After collection has been finished, the account sale is mailed over to the head office, which will accordingly settle the account with his consignor.

The selling charges in America are as follows:—

Charges *Ad varolem*	5%	of the selling price.
Direct exporter's commission	3%	„ „
Insurance against purchaser's bankruptcy	1.5%	„ „
Marine insurance premium	0.5%	„ „

Charges according to weight 3 cents per pound.
(storage, carriage, storing charges,
fire insurance premium, etc.)

The selling charges in France are as follows:—

Direct exporter's commission	3 %	of the selling price.
Broker's commission premium	0.5%	„ „
Fire Insurance premium	0.1%	„ „

Marine insurance premium	0.5% *on insured* value.
Storage, carriage, storing charges, wires, postage, and testing	Fcs. 15 per bale.

E. Direct Exporters at Yokohama.

(1) Yokohama Branch of the Mitsui Bussan Kaisha.
(2) Yokohama Kiito Gōmei Kaisha.
(3) Yokohama Dōshin Kabushiki Kaisha.
(4) Hara Gōmei Kaisha.

F. Amount of our Exported Raw Silk and its Destination.

The destination of our exported raw silk and refuse silk, and its amount and value are shown below:—

Amount of Exported Raw Silk.

Year.	For United States of America.	For France.	For Italy.	For Great Britain.	For Canada.	For Others.	Total.
	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.
1903	2.751.016	992.417	582.787	2.011	2.596	58.492	4.389 319
1904	3 937.508	1.138.489	701.909	14.913	1.061	1.270	5.795.150
1905	3.242.751	676.427	415.450	121	4.944	5.447	4.345.140
1906	4.407.023	1.260.814	514.861	1.914	44.294	1.258	6.230.164
1907	3.804.661	1.219.670	562.396	260	1.523	24.082	5 612.592
Average	3.628.592	1.057.563	565.485	3.844	10.883	18.110	5.284 477

Value of Exported Raw Silk.

Year.	For United States of America.	For France.	For Italy.	For Great Britain.	For Canada.	For Others.	Total.
	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.
1903	47.018.559	16.691.055	9.678.010	34.491	41.663	965.129	74.428.907
1904	60.747.832	17.090.337	10 639.184	227.096	17.127	19 126	88.740.702
1905	53.825.893	10.999.503	6 843.846	1.267	80.746	92.500	71.843.755
1906	78.392.085	22.085.916	9.094.696	34.032	813.031	23.040	110.442.800
1907	79.759.893	25.243.007	11.378.827	5.630	30.756	470 494	116.888.627
Average	63.948.852	18.421.964	9.526.913	60.507	196.665	314.058	92.468.958

Amount of Exported Waste Silk.

Year.	For United States of America.	For France.	For Italy.	For Great Britain.	For Switzerland.	For Austro-Hungary.	For Hong-kong.	For British India.	For Others	Total.
	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.
1903	70 665	2.549.520	230.743	358.278	78.981	177.943	95.040	3	937	3.562.120
1904	77.212	1.940.302	358.946	325.055	300.670	111 422	42.103	15.503	1.398	3.172.611
1905	42.217	3 050.042	273.446	314.883	322	56.199	131.728	33.824	60	3.902.721
1906	66.337	2.262.953	469.694	242.770	724	107.746	161 635	42.712	21.900	3.376.471
1907	54 532	2.510.310	572.371	58.298	21.408	139.455	—	25.960	7.738	3.390 072
Average	62.192	2.462.626	381.040	195.367	80.428	118.553	86.101	23.600	64.062	3.474.769

Value of Exported Waste Silk.

Year.	For United States of America.	For France.	For Italy.	For Great Britain.	For Switzerland.	For Austro-Hungary.	For Hong-kong.	For British India.	For Others.	Total.
	Yen.	Yen	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.	Yen
1903	200.047	5.372.044	594.529	79.963	255.844	387.215	65.905	3	1.771	6 957.321
1904	219.308	3.176.960	737 552	628.497	566.186	153.953	72.062	33 290	2.921	5.590.729
1905	130.759	4.923.729	463.501	455.271	600	81.656	118.847	58.726	75	6.233.164
1906	177.289	3.869.051	841.423	458 340	3.307	183 656	153.321	83.858	44.904	5.815.149
1907	209.627	4.623.956	877.178	137.966	43.699	290.339	—	53.211	7.329	6.243.305
Average	187.406	4.393 148	702.837	352.007	173.927	219.364	82.027	45.818	11 400	6.167.934

CHAPTER IX.

WILD SILKWORMS.

In Japan we rear not only the domestic silkworm (Bombyx mori L.) but two species of wild ones. There are several known species of silkworms found wild in our country. The *Kuwako* (Bombyx mandarina Moore) which has the same ancestor with the Bombyx mori, *Yamamai* (Antherea yamamai Guér-Mén) *Sakusan* (Antherea pernyi Guér-Mén), *Shōtyu* (Caligula japonica Moore), and *Chosan* (Attacus cynthia Drury). Among which we will sketch in the following pages about those which have practical use.

1. Antherea yamamai Guér-Mén.

Antherea yamamai is an indigenous silkworm in our country. Over one thousand years ago the silkworm was already described, from which it is thought that the silkworm has been known from the most ancient times. At the present time silkworms may be found in the forests of every district.

Their feeding was undertaken for the first time about ninety years ago in the prefecture of Nagano. Afterwards they were introduced into the neighboring districts. About forty years ago, their rearing was encouraged by the Financial Department, and along with the general rising of varous other industries among the people, the rearing became widely pracicted in every district spreading over the boundary of the prefecture of Nagano. Especially at Kita-azumi-gōri, Nagano,

a guild called the Matsukawa-gumi has been organized to carry on the enterprise energetically. But the attempt ended in failure owing to the difficulties of the work of rearing silkworms and people became fully aware of the disadvantages of the undertaking, according to the circumstances of the districts. At present the limit of the feeding sphere has become narrower, and the wild silkworms seem to be almost the special product of Minami-azumi-gōri and Kita-azumi-gōri, in Nagano prefecture. Although they are reared to some extent in other prefectures, such as Ibaragi and Chiba, yet the business is practiced by all the farming people of Nagano.

According to the latest investigations, the number of the breeding houses in the prefecture of Nagano, is 216 and in the others about forty. The yield of the cocoons varies greatly year by year and the number collected in 1907 was some 8,435,800; their price also varies yearly and in the same year that of the superior class of 1.000 cocoons was about five *yen*.

The bush of Quercus serrata Thumb. is the best of all as a feeding bush. Some of the other trees and shrubs on which the worms may feed are the Quercus glandulifera Bl., oak (Quercus dentata), chestnut (Castanea vulgaris) and others of the Quercus species, but the cocoons of the worms which are reared with the leaves of these plants have thin and weak layers.

For the plantation of the Quercus serrata, a coarse sandy place along a stream or a hill side facing towards the south east, is preferable. The sprouts should be prepared beforehand by the seedling process. The seeds gathered in the autumn, are

Antherea yamamai GUÉR-MÉN.

immersed in water for one or two days, then, they are sown either soon or at the close of March in the next spring after having been preserved in the earth, mixed with fine sand. Thus they germinate in May. The young plants, thus grown, are dug out in the following spring and transplanted. In the second year the beds are changed and the young plants are cultivated as vigorously as possible. They are transplanted in the third year to the farms for permanent plantation, and are planted in the ground in the proportion of one in five or six square feet. Afterwards they are so managed that the height of the stems as well as the branches will be six feet and that they may produce as many lateral branches as possible and if over grown, they should be cut off properly. Then weeding is practiced from time to time. Thus when after about ten years, the vigour of the trees may be impaired, then, they are cut down from their bases and new shoots are made to come out from their stumps.

The moths come forth from the latter part of August to the former part of September and lay eggs. For the preparing of seed, the cocoons which have a healthy pupa and thick layers, are selected and placed in layers with a silky pedical upward in a shallow box. The moths usually emerge at the end of thirty or forty days after they have entered into the pupal condition. Their wings are a bright yellow, a brown transverse line runs through them and a large transparent eye spot lies on both the fore and hind wings. Their length is 30 mm. (male) and 37 mm. (female). One or two pairs of female and male moths are transferred in a small bamboo basket within which they are allowed to couple and lay eggs. The baskets have a

bell shape, a diameter of about eight inches, a height of about ten inches and the width of the mesh is about one inch. After a while, the female moths will deposit their eggs on the outside of the basket, by putting their posterior parts out of the meshes. When the egg-laying process is finished, the moths are removed, and the baskets bearing the eggs, are hung down by means of string in a cool place, protected from sunshine, rain and dew. In January of the next year, the eggs are scratched off from the basket with the fingers and washed with clean water, then, they are spread over a wooden frame with a bottom made of hemp-cloth and are kept hanging down in an airy place. The eggs are nearly round and are of a dark grayish brown color. Before they are hatched out, the eggs are pasted on the middle of a long piece of paper in the proportion of ten to fifteen grains per each piece, in order to bind them around the branches of the food producing trees. This operation is practiced when the first worms are hatched. A tree which spreads its branches about six feet square, receives some five pieces of the papers. Hatched larva distribute themselves over every part of the food trees and grow by eating the leaves. The newly hatched larva has a dull ochre brown head and light yellow body but after being full grown, the color of the body changes into green and the subdorsal part of each segment is covered very coarsely with yellow hairs.

The number of the days during each age of development is as follows:—

The first age	15 days
The second age	10 „
The third age	10 „

The fourth age ...	...	...	...	...	...	...	10 days
The fifth age	...	...	...	...	...	...	15 „
	Total	...	...	...	...		60 „

On account of the fact that the worms are fed in the open fields, the climate has so great an influence upon them that in the rainy years, many of them will die and moreover their cocoons have thin layers; in the years of drought the cocoons have small sizes. Although these climatical influences are not capable of being avoided, the rearers should notice the following points, while they are feeding the worms; whether they are in want of food, owing to the incomplete growth of the leaves or the worms have eaten them all up, by gathering together in one place, as it sometimes happens. The rearers should endeavour to keep the worms and the leaves in the proper proportion, looking after the food plants from time to time.

There are several enemies to attack the worms: sparrows, Manchuria great tits, cuckoos, field mice, squirrels, tree frogs, spiders, wasps, ants, etc. For the protection against these enemies a kind of scarecows is made here and there, a gun with a blank cartridge is fired off occasionally, trenches are dug out round the food trees, or the weeds under the trees are got rid of.

The mature worms finish spinning their cocoons in one or two days, then, after three or four days the cocoons are collected. On account of the fact that they are colored so green and are so wrapped up with leaves, that they are often overlooked, it is difficult to gather them. In general, a skilful gatherer may collect five hundred cocoons in one day. Seventy per cent. of the total amount of worms distributed, is usually lost during the feeding season, so that about seventy thousand

seed-grains are distrituted among the food bushes in one *cho**, but the crop is only about twenty thousand cocoons.

The cocoons are of a bright green color and oval. Their length is 46 mm., their breadth 23 mm. on the average. The average length of the filaments taken out by unwinding a single cocoon is 520 metres and the average titre 5.41 denier. The thickness of the filaments of the cocoons is greatest in the outside layer and is gradually reduced in the innermost layers.

For reeling the cocoons have been stifled beforehand by steam or heat, and then have been boiled. After these operations, they are reeled in the same way as we do in the case of the cocoons of the domestic silkworms. On account of the imperfect unwinding of the filaments, owing to their sticking to each other by means of a gummy substance, to the cooking and reeling water should be added small pieces of Marseilles soap. About eight *momme* of raw silk may be reeled on the average from a hundred cocoons. The produced raw silk is light green and strong, its luster is fine.

The product is partly made into cloth in the district that has produced it, and is partly used to comply with the demands from other parts. In 1907, 1090 kilograms of raw silk was sent into Gifu, Tochigi, Niigata, and Aichi prefectures from the Minami-azumi districts of Nagano. Its market price varies sometimes, but at present one *kwan* of it costs about 65 *yen*.

2. Antherea pernyi Guér-Mén.

A. pernyi originated in China, where it seems to have been reared in the north part from the most ancient times, and

* one *cho* = 245 acres.

Antherea pernyi GUÉR-MÉN.

was imported into Japan at first in 1875. At that time the worms were experimentally reared at Sapporo in the Hokkaidō, and in Tōkyō. They excited the curiosity of the people and were gradually propagated into every district, but many of the rearers had no experience in the matter and reared them only for their own amusement. For these reasons, almost all of the rearers failed and were compelled to stop the work of feeding silkworms. The districts of the feeding of the worms became narrower and narrower.

The rearing of the worms began in 1880 in the prefecture of Nagano, where the people fed them in the same way as had been used in the rearing of A. yamamai, and now Minami-azumi-gōri and Kita-azumi-gōri in the same prefecture are the most important among all the districts for the feeding of these worms. Besides these districts, the rearing is practiced to some limited extent in various places in the prefectures of Ibaragi, Tochigi and the Hokkaidō.

According to the investigations carried on in, 1907, the number of the houses of the rearers of the *spring* breed is 170, the crop amounts to 5,495,600 cocoons and these of the *autumn* breed to 97, the crop being some 745,000 cocoons. The yield of the other districts is so small that it is not necessary to describe it here.

As food plants of the worms, Q. serrata Thumb. is preferable. They may be fed with other plants, Q. glandulifera Bl., Q. dentata, Q. glanca Thumb., Forma serica, Q. glabara, Castanea vulgaris, etc., but they produce inferior cocoons, when they are reared with these leaves. The food plants are similarly managed and cultivated as in the former case.

A. pernyi appears twice a year. The spring breed comes forth in the latter part of May, matures after about 50 days and spins a cocoon. The *autumn* breed emerges in the middle of August and spins a cocoon after about 40 days.

The cycle is shown as follows:—

The spring breed.

The number of the days of the first age		6	days.
,,	,,	the second age 7	,,
,,	,,	the third age 9	,,
,,	,,	the fourth age 13	,,
,,	,,	the fifth age 15	,,
		Total 50	,,

The moths appear at the end of 25 days after they have become pupae, couple and lay eggs which will hatch after about two weeks.

The autumn breed.

The number of the days of the first age		4	days.
,,	,,	the second age 5	,,
,,	,,	the third age 6	,,
,,	,,	the fourth age 10	,,
,,	,,	the fifth age 14	,,
		Total 39	,,

The worms pass the winter in the pupal state and the moths appear in the early part of May of the next year and deposit eggs after coupling. The wings of the moths are a yellowish brown and each of them have a transparent, circular

spot surrounding which is a border of red and black lines. The body-length of the male is 32 mm., that of the female some 40 mm..

For the selection of the breeding stock, cocoons should be thoroughly differentiated after they are gathered. The cocoons fot the *spring* breed are placed side by side in a basket which is put away during the winter and the early spring in a well ventilated and rather warm place, kept away from the direct sunshine. When the moths appear, each one or two pairs of them are then transferred into such a bamboo basket as that we use in case of A. yamamai, within which each pair is allowed to couple and lay eggs. The latter are scratched off from the basket with the fingers after two weeks. The *autumn* breed deposits eggs in the same way which are scratched off after one week. The eggs are oval, their diameter 3 mm. For the rearing of the worms, about twenty eggs ore pasted on each piece of paper and before hatching, they are distributed among the food shrubs in such a way that each piece is bound up and around the branches, with the eggs turned down, avoiding the direct sunshine. About 130,000 eggs are scattered in every *chō*. Thus after hatching, the rearers should endeavor to keep the uniform distribution of the worms, looking about the feeding bushes from time to time, and also take care to protect them from their enemies. A. pernyi is more vigorous and less attacked by diseases than A. yamamai. On this account, it is less necessary to select carefully the feeding places. Even in the most unfavorable conditions for A. yamamai, such as the luxuriance of foliage and too much rain, the former may grow up healthy and vigorous. The cocoons are gathered

several days after the worms finish spinning and being brown and just like the withered leaves, their collection is a troublesome work to any one without skill and experience.

The yield in every one *chō* is from 20,000 to 25,000 cocoons. The cocoons of the *spring* breed have somewhat different qualities from those of the *autumn* breed; namely, the latter unwind with more difficulty than the former, so the *spring* cocoons are chiefly used for filature, while the *autumn* ones are used for breeding purposes. Their length is two inches, and their breadth on the average one inch.

The average length of the filaments of a single cocoon is 650 metres and the average titre is 4.86 denier. Their titre varies so that small in the outer layer, gradually becomes great in the middle and then again small in the *innermost*.

For reeling the cocoons, a special method is adopted owing to the difficulty of unwinding them. A method which has been hitherto practiced in the prefecture of Nagano, is to steam the cocoons a long while with some soda before reeling them, but the improved method is to treat them with hydrochloric acid, then, to boil them several hours with bicarbonate of soda and soap, and afterwards to real them on a plate. From seven to eight *monme* of the raw silk may be reeled from 100 cocoons on the average. The raw silk is a light brown color and similar to that of the Indian Tussah. It is partly woven in its own habitant and partly in compliance with the demands of the weaving factories in the prefecturers of Gifu, Tochigi, Niigata, Aichi, Kyōto and Saitama.

In 1907, 812 kilograms of the raw silk were produced at Minami-azumi-gōri, Nagano. The market price varies from

year to year, but on the average the price of yamamai raw silk of a superior quality is about 35 *yen* per *kwan*.

3. Caligula japonica Moore.

Cocoons of the *Shōsan* or Caligula japonica are found wild in the forests of every district in our country. There are none who rear the worms, but only their cocoons are gathered. The districts, where the cocoons are found, are different sometimes, but at present they are collected in Iwate, Fukushima, Tochigi, Nagano, Gumma, Yamagata and Miyagi prefectures in the north eastern part of Japan and in Hiroshima, Okayama, in both of which they are found in large numbers, and in some districts of Kyushū and Shikoku in the south western part.

The worms appear once a year. In the vicinity of Tōkyō, the eggs hatch from the latter part of April to the early part of May. The larvae feed themselves on the leaves of camphor trees (Cinnamomun camphor), Chestnuts (Castanea vulgaris), Rhus vernicifera, Walnuts (Juglans species), etc.. They mature from fifty to sixty days after hatching, moulting four times, they then come down from the trees to spin cocoons on the twigs of shrubs, three or four feet high above the surface of the ground. The cocoons are an elongated oval in shap, composed of net-work layers and one end is open. The moths come forth about August or September, couple soon after and lay eggs on the twigs at the lower part of the trees that produce leaves for their food. The eggs will hatch during the next spring.

The moths have grayish brown colorations, with green lines on their wings. On each of their hinder wings lies an eye

spot whose inner side is bordered successively by concentric rings, differently colored and their fore wings also have a grayish spot in shape like a boat. The mature larvae are green and provided with long white hairs. The cocoons of the worms, not being fit to reel, are developed into floss silk which is then either spun into threads or used for various purposes without being spun.

The cocoons may be gathered from July to May of the next spring. On account of fact that when they are left in a field for a long while, their qualities become vitiated, the superior ones may be collected at any time until the autumn. They are boiled with a little soda at first, thus softened, and washed with water, they are pressed with a machine, and then stretched into floss silk, after the pieces of leaves and the cast-off-matter of the worms on them has been picked away. The floss silk, made into a moderate size, is hung down in a room. After drying, we will have a yellowish brown silk which has a fine lustre and feels soft.

The amount of the cocoons produced, varies every year, according to the climate, but on the whole, the annual production is about 188,800 kilograms, that is to say, 50,000,000 cocoons.

Although floss silk is more or less in demand in the interior, the greater part is exported chiefly into France and Germany and next into England and Hong-kong.

According to the relation between demand and supply, the market price of the floss silk varies so greatly as to be some 350 *yen* per 100 *kin*, when dear, while it costs the half of that price, when cheap.

CHAPTER X.

CONCLUSION.

The progress and the present state of the sericultural industry of Japan has, we presume, been clearly and fully treated of in the preceding chapters. Here we shall conclude by giving another review of the state of this industry in the past and the present so that we may form some opinion as to the future development of this industry.

I. The Sericultural Industry of Japan has a Long History and a Firm Standing.

The origin of the sericultural industry of Japan is very old, but the first stage of its development was in the reign of the emperors Chiū-ai and Ō-jin. The warm encouragements given by the successive emperors and empresses had indeed very much to do with the rapid progress it attained after that time.

Another important cause in the growth of this industry was the adoption of silk fabrics for the payment of taxes as well as for wearing purposes. By this time, silk-raising attained such an importance that it was considered one of the most lucrative branches of industry. Thus aided by the Imperial encouragements, the foundation of this industry had been so strongly laid in the hearts of the people that even the long series of political as well as economical vissicitudes that this industry passed through, could not entirely destroy it, until towards the close of the Tokugawa Régime it began to show signs of a new life. At

this juncture, the port of Yokohama was fortunately opened for foreign trade and the exportation of our silk was practiced there for the first time, which led to the sudden activity of this long-suppressed industry.

Since the Restoration in 1867, the newly established government, in sympathy with the desire of the Imperial Household, turned its utmost attention towards the improvement of the industry by bringing in many equipments in the way of protection and encouragement with the same enthusiasm that was shown by the Imperial Courts in ancient times. These governmental enterprises combined with the individual efforts of the people have an ample share in the development and prosperity the sericultural industry of Japan enjoys at present.

II. The Present Development of the Industry of Japan is Sound and Wholesome.

As the silkworm rearing in Japan is managed mostly as a subsidiary work of farmers, being pacrticed at less busy times of farming, it is naturally safe from any serious fluctuations in its work and management, such as might be caused by a single failure of a crop or sudden falls in the prices of cocoons. The work of filature, on the contrary, being carried on as a special industry, is subject to the fluctuations of the prices of raw silk and various other economical circumstances, far more than silkworm rearing. But many years' experience of those concerned in this industry have succeeded in discovering effective measures to overcome these difficulties, so that practical management has become much easier and safer, being less subject to serious apprehensions. Moreover, as has often been

referred to, the recent perfection of the equipments for sericultural education, the encouragement, and protection as well as for the prevention of silkworm diseases, have caused a remarkable advancement in the knowledge and practical art of silkworm rearers and raw silk reelers, giving safety and steadiness to the management of this industry.

III. The Progress of the Sericultural Industry of Japan has Reasonable Causes.

We have already seen that the recent striking progress of the sericultural industry in Japan is due to a great extent both to the Imperial encouragements and to the dauntless endeavors of the people, but at the same time we must take into consideration another important factor, the presence of the various conditions necessary for the practical management of this industry.

As the climate of Japan is generally mild, the cultivation of mulberry trees and the rearing of silkworms are carried on quite extensively from Formosa to Hokkaidō, and the geographical feature of the country being mountainous, the level land fit for the cultivation of rice and wheat is rather scarce, while we can meet with everywhere tracts of sloping land, which are favorable for mulberry plantation. The green hills and deep forests that can be found everywhere throughout the country are natural reservoirs of water, so that water power is freely applied to mechanical purposes, thus giving a strong facility to the improvement of the reeling industry.

As silkworm rearing is rather a tedious process of handling he delicate insects, it naturally admits of little or no room for the application of mechanical force, depending very much on

manual labor. Filature, on the other hand, has adopted the factory-system introducing highly improved reeling machines. Nevertheless, manual art has much to do with the reeling work, which is the most important process of filature. The natural artistic skill and the hereditary customs of the Japanese are very favorable for the mastery of the delicate process of reeling work.

Most Japanese farmers are engaged in the cultivation of the land only, and stock-breeding is not yet widely practiced, as a result of which, some waste of the time of laborers cannot be avoided between sowing, weeding, and harvest, even though enough care is taken for the regular distribution of labor in the cultivation of rice, wheat, vegetables, and other products. Silk-worm rearing is indeed praticed by taking advantage of such surplus of labor, without requiring any heavy expense for its special purposes. Moreover, this work can be easily managed by women and girls, who would be less productive in other lines of work. This is indeed another great economical merit of this industry. In short, Japan is gifted with every favorable condition natural, geographical, and economical, for the progress of sericulture, which she has attained throughout the long course of her eventful history.

IV. The Production of Japanese Silk occupies Thirty Five Per Cent of That of the Whole World, and its Greater Part is Exported to the World's Markets.

The silk-producing countries throughout the world are fully twenty. But those countries that produce so much silk as to be

able to meet the demand of the world's markets are only three or four. According to the report published by the silk-dealers' guild in Lyons, the total output of silk throughout the world in 1907, amounted to 24,500,000 kilograms (the figures for the four Eastern Asiatic countries being those for exported silk) The silk exported from Japan in the same year was 6,350,000 kilograms, while the total output of Japanese silk reached 8,760,000 kilograms. So Japan produced 35 per cent. and exported 25 per cent. of the total output of silk throughout the world in that year. The comparison of the figures with the statistics of 1897 will give some idea of the increase of our silk production during the last ten years:—

Year.	World's product.	Japan's product.	Japan's export.
	Kg.	Kg.	Kg.
1897	17.000.000	5.760.000	3.500.000
1907	24.500.000	8.760.000	6.350.000

Thus it may be seen that the quantity of raw silk supplied to the world's markets by Japan ten years ago was 3,500,000 kilograms, making 20 per cent. of the total output of the world, while at present, the rate has increased to 26.5 per cent.

These considerations led to the conclusion that it would be more profitable for Japan to increase the export of raw silk than to attempt the furtherance of silk weaving industry, and in accordance with this view, efforts are being made now both by the government and the people with an unanimous intention for the further increase and betterment of our raw silk. The filature instruction in the Tōkyō Sericultural Institute and the silk conditioning work at Yokohama described in the preceding chapters are intended with this special object in view.

V. The Sericultural Industry of Japan Promises a Further Development.

The development of the sericultural industry of Japan in the past has already beed dwelt upon at length. In conclusion, we shall try to make some observations and remarks as to the possibility of its future development.

The area of land used for the annual production of 8,000,000 kilograms of Japanese silk covers 400,000 *chō*, and the labor required for the purpose is supplied by the farmers at less busy times of farming. The total area of uncultivated land fit for agricultural purposes extends over some 4,500,000 *chō* throughout the Empire with the exclusion of Formosa, and this vast area of land is more fitted for the cultivation of mulberries in every respect. It goes almost without saying that the national expansion of Japan will not long leave such land unclutivated, the necessary sequel to which will be the utility of the same chiefly for sericultural purposes.

As already alluded to, silkworm rearing depends chiefly on manual labor with little chance for the application of machinery. The supply of labor, therefore, constitutes a problem worthy of much deliberation in the management of this industry. In Japan, however, the vast population together with the favorable economical circumstances has been effective in preventing the want of labor-supply, and the annual increase of population by half-a-million furnishes us with a strong reason to hope that we may make use of the surplus population for the cultivation of such valuable yet untouched land as well as general sericultural management.

It has been an old custom in Japan that women should not partake in any labor but those pertaining to their household duties, depending upon their husbands for subsistence. In fact, it is not rare cases to be met with that girls born in the heart of a large city should grow up to womanhood without the least idea about the refreshing verdure of rice fields so common in Japan. Happily, however, this sedentary habit is gradually giving way to the present pressure and those women are increasing in number who propose to be engaged in some sort of lucrative industry. And it is much to be gratified that this tendency is also given encouragement by more sensible classes of the community. Under such a state of things, there is little or no fear that sericulture, which is an industry best fitted for the delicate character of woman, should be neglected by the prudent house-wives and daughters of Japan. In fact, it is to our great satisfaction that the female education in sericulture is making a steady progress.

To sum up, the present state of land and labor-supply is thus favorable, and other various conditions are as satisfactory, while the customary modes of life of the people are, as above mentioned, perfectly fitted for the economical management of sericulture. Moreover, the government and the people are unanimous in giving efforts for the furtherance of the industry, and above all, the Imeperial Household, the leading force of all national activities, in all times has condescended to set an example to the people by personally being engaged in the work of silkworm rearing. It may, therefore, safely be predicted that the expansion and development of the sericutural industry

of Japan in the future will be far greater than what it has been heretofore.

[END.]

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